# PHILIPS

## Service manual

## Dual-trace oscilloscope PM3250(X)

730416/04

# Contents

# List of figures

# IX. Circuit description

## A. INTRODUCTION

The information contained in this manual applies to the /04 version of the PM 3250 oscilloscope.

## B. GENERAL

The PM 3250 oscilloscope comprises a number of units, some of which are further divided into sub-units as shown in the following table:

| *UNIT No* | *DESCRIPTION* |
|---|---|
| 1 | Supply unit |
| 2 | Supply panel (part of unit 1) |
| 3 | Unblanking amplifier (part of unit 1) |
| 4 | Chopper panel 1 (part of unit 7) |
| 5 | High tension unit (part of unit 7) |
| 6 | Chopper panel 2 (part of unit 7) |
| 7 | Chopper unit (part of unit 1) |
| 8 | Diode panel (part of unit 1) |
| 9 | Calibration unit |
| 10 | Time-base |
| 11 | Delayed time-base (part of unit 10) |
| 12 | Main time-base (part of unit 10) |
| 13 | Delayed time-base switch (part of unit 10) |
| 14 | Main time-base switch |
| 15 | Preamplifier A compl. |
| 16 | Preamplifier A, panel 1 (part of unit 32) |
| 17 | Preamplifier A, panel 2 (part of unit 33) |
| 18 | Attenuator A switch (part of unit 15) |
| 19 | Preamplifier B compl. |
| 20 | Preamplifier B, panel 1 (part of unit 34) |
| 21 | Preamplifier B, panel 2 (part of unit 35) |
| 22 | Attenuator B switch (part of unit 19) |
| 23 | Horizontal output amplifier |
| 24 | Vertical output amplifier |
| 25 | Trigger pick off stage |
| 26 | Electronic switch driver (a) and intermediate amplifier (b) |
| 27 | Rear face assembly |
| 28 | Front face assembly |
| 29 | Potentiometer bracket (part of unit 31) |
| 30 | Potentiometer bracket (part of unit 31) |
| 31 | Partition plate |
| 32 | Preamplifier A, panel 1 (part of unit 15) |
| 33 | Preamplifier A, panel 2 (part of unit 15) |
| 34 | Preamplifier B, panel 1 (part of unit 19) |
| 35 | Preamplifier B, panel 2 (part of unit 19) |
| 36 | Drift reduction amplifier |
| 37 | Modulator unit (2 pieces fitted on unit 36) |
| 43 | Line-Field sync. unit (PM 3250X) |

## C. VERTICAL AMPLIFIERS

### 1. Preamplifier with drift reduction

#### a. Introduction

The following circuit description applies to the preamplifiers of channels A and B. Since these two preamplifiers are identical, only that of channel A is described. The circuit diagram of the channel A preamplifier is shown in Fig. XIV-3 and XIV-4.

#### b. Input coupling

The AC/0/DC switch SK21 enables the input signal to be either a.c. or d.c. coupled to the input attenuator. When the switch is in the '0' position, the input socket is isolated from the attenuator and the input of the attenuator is connected to earth.
Capacitor C101 is discharged by means of resistor R101 whenever the AC/0/DC switch SK21 is in either the DC or '0' position. This protects the circuit from which the input signal is being taken, from discharges which might otherwise occur when SK21 is transferred to the AC setting.

#### c. Deflection sensitivity control

The deflection sensitivity attenuator switch (i.e. the AMPL switch SK26) has 13 calibrated settings ranging from 2 mV/div. to 20 V/div.
For deflection coefficients of 2 mV/div., 5 mV/div., and 10 mV/div., the gain of the amplifier is changed. For the remaining deflection coefficients, frequency-compensated attenuation resistors are inserted into the input circuit. Trimmers, connected into the attenuator circuit, enable a constant value of input capacitance to be set up.
The GAIN switch SK22, which is part of the delay line driver circuit, enables the vertical deflection sensitivity to be increased by a factor of 10. The increase in deflection sensitivity necessitates a corresponding reduction in bandwidth, in order to limit noise. This is effected in the intermediate amplifier, see chapter C.4.

#### d. Input source follower

A field effect transistor connected in common source configuration, provides a high input impedance, whereas the output from which the next amplifier stage is driven, has a low impedance.
Two diodes (GR101 and GR102) are provided as safeguard against too high input voltages.

#### e. Preamplifier stages with feedback

The preamplifier which follows the input source follower consists of two stages of amplification. Each stage comprise transistor pairs with shunt and series feedback. The transistors contained in the first and second stage respectively are TS102-103-106-108 and TS107-109-111-112.
For deflection coefficients of up to 20 mV/div., the AMPL switch is used to adapt the gain of the amplifier by inserting different values of resistance into the emitter circuits of transistors TS107 and TS109. The remaining deflection coefficients are obtained by using SK26 to select a frequency-compensated input attenuator circuit.
Reference to the following paragraph dealing with drift compensation will show that the 1/A attenuator must be altered to suit a selected gain. This alteration is made by means of resistors R129 and R131 which are switched into circuit at the settings of the AMPL switch SK26 (i.e. at deflection coefficients of 2, 5 or 10 mV/div.).
When deflection coefficients of 20 mV/div. or more are selected, the gain of the amplifier is fixed at an exact value which suits the 1/A attenuator, by means of potentiometer R122. Correct operation of the drift compensation system is dependent upon accurate gain setting.

In the most sensitive setting of the AMPL switch, the amplifier gain is determined by R143, and by other fixed resistors in the 5 mV/div. and 10 mV/div. positions.
The signal and its associated trigger signal are taken asymmetrically from the AMPL. continuous control potentiometer R14 and from the emittor of TS113 respectively.
Overall gain of the vertical amplifier may be adjusted by means of the GAIN ADJ potentiometer R10 which is accessible via a hole in the front plate.
Optimum frequency and step response are obtained by the feedback loops and RC networks in the emitters of the amplifier circuit stages.

### f. Drift compensation

A drift compensation circuit, the main section of which is an extremely low-drift chopper amplifier, has been incorporated in each vertical amplifier. A detailed description of the chopper amplifier circuit for channel A is given in section **g.** The chopper amplifier for channel B is identical to that of channel A.
Assume that −A is the gain of the vertical amplifier whose drift is being compensated for.

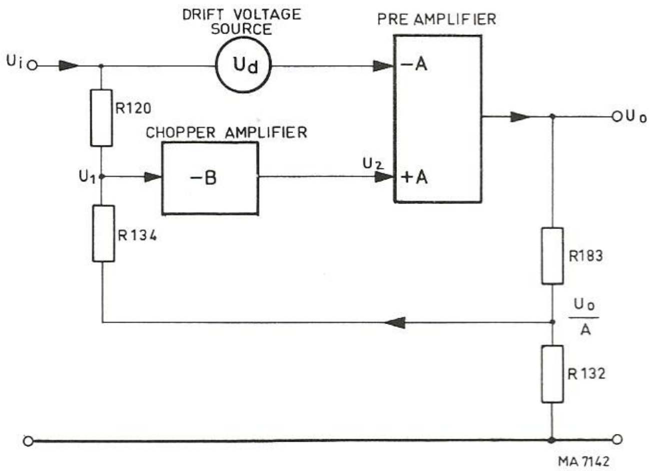



*Fig. IX-1. Simplified diagram drift reduction circuit*

The drift voltages in the vertical amplifier are referred to the input, and are assumed to originate from an imaginary voltage source $U_d$. The input voltage is $U_i$ so that the output voltage before drift compensation, can be expressed as $-A\,(U_i + U_d) = U_{o1}$.
A voltage divider (R183 and R132) attenuates the output voltage of the vertical amplifier by a factor of A, hence the voltage divider output may be expressed as $\frac{U_o}{A}$. This quantity $\frac{U_o}{A}$ is added to the input voltage $U_i$ by means of two high-value resistors R134 and R120.
The resulting output $U_1$ is applied to the drift compensation amplifier (chopper amplifier) which has a gain of −B. The output of this amplifier, $U_2$, is fed to the vertical amplifier as a correction signal.
The system is shown schematically in Fig. IX-1, and it can be seen that:

$$U_{o2} = -A\left(U_i + \frac{U_d}{1 + \frac{B}{2}}\right)$$

This formula can be used to show that after drift correction, the output voltage $U_{o2}$ contains $\frac{1}{1 + \frac{B}{2}}$ less drift voltage than $U_{o1}$.
When, therefore, the gain of the chopper amplifier (−B) is high, drift can be neglected.
Capacitor C116 is connected into the drift compensation circuit when the AC/0/DC switch is set to AC. When a signal with a high d.c. component is applied to the circuit, a considerable d.c. component will be present at the input of the amplifier; to compensate for this, C116 is introduced so that the d.c. level is kept at zero by the chopper amplifier.

### g. Chopper amplifier

The drift compensation chopper amplifier modulates its input signal using a square-wave signal (approx. 1700 Hz). After amplification, the signal is demodulated so that the phase relationship is maintained. This demodulated output, which is the amplified drift signal, is applied to the vertical amplifier.
The modulator section of the circuit is formed by by two m.o.s. field effect transistors (TS1408 and TS1410) which are alternately driven. To avoid any influence from humidity the modulator section has been moulded in a nine pin encapsulation.
The modulated signal is amplified (approx. 4000 $\chi$) by an integrated operational amplifier (IC1401).

The amplified signal is applied to the demodulator which consists of a pair of m.o.s. field effect transistors (TS1401 and TS1402) which are alternately driven by the above mentioned square-wave signal.
The astable multivibrator TS1409 and TS1411 acts as the driver for the modulator as well as the demodulator. In addition, the multivibrator also provides driving signals for the chopper amplifier of channel B. Capacitor C1403 counteracts spikes on the signal which are caused by differences in circuit and transistor capacitance. The offset voltage is compensated by means of potentiometer R1406.
The output d.c. voltage of the drift reduction amplifier is connected together with a d.c. voltage from the d.c. balance pot. meter (at front panel) to the anti-phase input transistor (TS104) of the preamplifier.

**2. Intermediate amplifier**

In the intermediate amplifier circuit diodes GR1601, GR1602, GR1603, and GR1607 perform the switching operations in the mode selection circuitry.
When the A/OFF/A—B switch SK20 is set to A, a negative 12 V supply is connected to R1605: diodes GR1602 and GR1607 therefore conduct. The circuit input is then formed by TS1601 and TS1604 so that the A channel signal is connected to the intermediate amplifier.
At the same time, resistor R1608 is positive so that diodes GR1601 and GR1603 are switched off causing transistor TS1603 to cut off.
To eliminate the crosstalk which might otherwise be introduced via TS1603, diode GR1605 is cut off and GR1606 is switched on. Any unwanted signals are thus isolated from the remainder of the circuit.

Setting the A/OFF/A—B switch to A—B results in a negative 12 V supply being connected to R1608.
This makes transistor TS1602 conduct so that diodes GR1601 and GR1603 also conduct.
The negative supply to R1605 is interrupted and diodes GR1602 and GR1607 are cut off. At the same time, diodes GR1605 and GR1606 change states so that TS1603 is fully operational as the channel B input of a differential amplifier.
Sensitivity change involved in switching between the A and A—B modes of operation may be eliminated by selection of R1615 which is in parallel with R1614. The tendency towards a change in sensitivity whilst switching between the A and A—B modes, is due to the rather large value of base resistor for TS1604 (which is in common base configuration). The overall emitter resistance of this transistor is significantly increased by the resistance present in the base circuit.
When the A/OFF/A—B switch is set to OFF, transistor TS1601 is functioning (via GR1602) but the A channel signal is blocked in the electronic switch.
Switch B/OFF/—B SK25 controls directly the electronic switch in the B channel part of the intermediate amplifier.

**3. Electronic switch and switch driver**

An electronic switch is used to control the gating circuitry which gates the intermediate amplifier outputs to the delay line driver.
The electronic switch is also used to transfer channel B signal to the horizontal amplifier when the oscilloscope is used for X-Y displays.
The electronic switch signals originate from a multivibrator which is formed by transistors TS512 and TS513. This multivibrator is driven by a blocking oscillator (TS517) that is free-running provided switch SK23 is set to the CHOPP.-position and both channels are in operation. When SK23 is set to ALT, relay RE503 is energized and trigger pulses are applied to the blocking oscillator by the closed contacts of this relay. Channels A and B may then be displayed alternately since the trigger pulses (which are obtained from the main time base via the amplifier formed by TS518 and TS519) are a replica of the unblanking pulses.
There are two other conditions which cause relay RE503 to supply trigger pulses to the blocking oscillator, i.e.:

1. One or both channels switches set to OFF
2. X DEFL switch set to EXTERN via $Y_B$

In these two particular conditions the multivibrator is kept stable.
Application of the trigger pulses then serves only to prevent spikes which might otherwise occur on the display should the blocking oscillator be free-running. Hence, the free-running condition is only obtained when the switch SK23 is set to CHOPP. and both channels are in operation. In all other conditions the blocking oscillator is driven by the trigger pulses, irrespective of whether or not the multivibrator is being switched. When both channels are in operation, the two driver signals which are opposite in polarity and which are obtained from the multivibrator, are applied to:

1. the base of transistor TS407 in order to control channel A output to the delay line driver, and
2. the bases of transistors TS412 and TS414 in order to control channel B outputs to the delay line driver

The transistors enumerated in 1 and 2 above, switch associated gating circuits (formed by GR401, GR402, GR403, and GR404 for channel A, and GR416, GR417, GR418, and GR419 for channel B) which transfer the display signals to the delay line driver, or to the horizontal amplifier.
If the A/OFF/A–B switch is set to its OFF position, a negative 12 V supply is connected to diode GR503 and the collector of TS512 becomes positive. Transistor TS513 then conducts and the multivibrator is held in this state (i.e. TS513 conducting and TS512 not conducting) until a further channel switching operation is made. The electronic switch is therefore set in the condition which causes TS407 to switch on diodes GR402 and GR403. Channel A is therefore blocked. As previously described, RE503 is energized by a negative supply obtained via diode GR518 and SK20. The blocking oscillator runs due to the trigger pulse train, although the multivibrator is not driven. The state of the multivibrator is reversed by setting the B/OFF/–B switch to OFF whilst the A/OFF/A–B switch is set to either A or A–B. In this circumstance the input to the horizontal amplifier is totally blocked due to the conduction of diodes GR1155 and GR1157. Relay RE503 is energized via GR517.
In addition to this, both channels may be simultaneously blocked by setting both channel control switches to OFF. The intermediate amplifier output is normally isolated from the horizontal amplifier due to the conduction of diodes GR1152 and GR1153 as well as the non-conduction of GR1151 and GR1154 (also by the non-conduction of GR1155 and GR1157 if the B/OFF/–B switch is set to OFF).
However, if the X DEFL switch is set to EXTERN via $Y_B$ diodes GR1151 and GR1154 are made to conduct and GR1152 and GR1153 are switched off by means of a positive potential which is applied via the closed contacts of switch SK10. In addition to this, transistor TS514 conducts so that TS513 is switched off. Transistors TS412 and TS414 therefore conduct and diodes GR417 and GR418 open whilst GR416 and GR419 cut off. The various diode states now provide a condition in which the channel B input to the delay line driver is blocked and the horizontal amplifier is opened to accept signals from channel B.
When the GAIN switch SK22 is set to its x10 position, +24 V is connected, via resistor R576, to the junction of GR519 and C528. This results in GR519 conducting, since its cathode is at a potential of +12 V, and so the capacitor C528 shunts C524. The blocking oscillator frequency is consequently reduced from 1 MHz to approximately 200 kHz and an improvement in circuit operation is obtained.

**4. Delay line and delay line driver**

Outputs taken from the electronic switch are applied to a three stage delay line driver prior to being applied to the 65 ns delay line L603.
The first stage of the delay line driver is formed by transistors TS417 and TS419. Shunt feedback is provided by means of transistors TS416 and TS418.
The second stage consists of TS421 and TS423 which are controlled by the GAIN and BEAMFINDER switches. With GAIN switch (SK22) in the x1 position the +24 V supply is connected to R446 via GR425, and the collector load of TS421 and TS423 consists of R448 and R453 (in parallel to R437 and R443) because GR426 and GR427 are conducting via R460.
In the x10 position of the GAIN switch, the collector load of TS421 and TS423 is increased, because +24 V is connected to R449, so that GR426 and GR427 are blocked. At the same time the emittor current of TS421 and TS423 is decreased because +24 V is now fed to the emitters via R425.
By the increase of the collector load also upper bandwidth limitation (to approx. 5 MHz) is obtained.
The third stage of the delay line driver formed by transistors TS422 and TS424 provides compensation for the signal loss incurred in the delay line.

**5. Vertical output amplifier**

The signal obtained from the delay line is applied to the vertical output amplifier which consists of three stages. The first stage is formed by TS602 and TS603, with TS601 and TS604 providing feedback.
Transistors TS606 and TS607 are connected as an intermediate stage with series feedback.
The third stage is a single-ended push pull output circuit with shunt feedback which is formed by transistors TS608, TS609, TS611, and TS612. Adjustment of driving range symmetry is by means of potentiometers R632, R633, R638, R642 and R643.

## D. TRIGGER PICK-OFF STAGE

The trigger pick-off stage is arranged as two separate circuits, one for channel A and the other for channel B. The circuit for channel A is also used to produce an A-B trigger signal when the oscilloscope is operating in the differential mode.

Signals from preamplifiers A and B are connected to the respective trigger pick-off circuits in order to drive the main and delayed time-bases.
The signal from preamplifier A is applied to the base of transistor TS501 which is in emitter follower configuration. The base of the second emitter follower (TS504) is connected to earth via the closed contacts of relay RE501 provided that the oscilloscope is not operating in the differential mode. With the A/OFF/A–B switch SK20 set to A, the channel A signal passes via TS501, to the amplifier stage which is formed by TS502 and TS506. This amplifier stage produces two identical outputs; one for the main time-base and the other for the delayed time-base.
The signal from preamplifier B is connected, via emitter follower TS507, to the amplifier is formed by TS508 and TS511. Two identical outputs are produced (one for each time-base).
If the A/OFF/A–B switch SK20 is set to A–B, relays RE501 and RE502 changeover. This causes the earth connection to be removed from TS504 due to the open contacts of RE502. At the same time, closure of RE501 contacts applies the signal of channel B to the base of emitter follower TS504. The amplifier formed by TS502 and TS506 then acts as a difference amplifier, so that the resulting trigger outputs to both time-base are an A–B function.
When the GAIN switch SK22 is set to x10, additional resistance is inserted into the emitter circuits of both trigger pick-off amplifiers (consequently amplification is increased by 10).
Transistor TS503 is connected as a current source which provides a high common mode rejection factor during the formation of differential trigger signals.

## E. MAIN AND DELAYED TIME-BASES

### 1. Main time-base

#### a. Introduction

The trigger signals derived from the trigger pick-off stage (U25) are applied to the main time-base trigger amplifiers which are located on unit 12. An additional input circuit on unit 12 is for external trigger source signals which are connected to the oscilloscope via the main time-base TRIGG. socket BU1.
The selected trigger signal (channel A, channel B, or external) is applied via the coupling switch SK2 to the pulse shaping circuits of the main time-base.

#### b. Trigger amplifiers

The following circuit description applies to the trigger amplifiers of channel A and channel B. Since these two amplifier circuits are identical, only that of channel A is described.
The channel A trigger signal (or the A–B signal when the oscilloscope is operating in the differential mode) taken from the trigger pick-off stage is applied to the base of transistor TS901. The emitter potential of this transistor is held constant by TS902, and its base bias is set by the preset potentiometer R901. The output of this trigger amplifier is connected to the contacts of the trigger source switch SK2.
External trigger signals connected to the oscilloscope via the main time-base TRIGG socket BU1 are passed to two emitter followers (TS906 and TS907).
The network which couples BU1 to the two emitter followers includes a capacitor C907 which is shorted if the coupling switch SK3 is set to DC. The network presents a constant input impedance of 1 MΩ in parallel with 20 pF, and affords protection against high input voltages.

#### c. Trigger multivibrator

The particular trigger signal to be used to drive the trigger multivibrator is selected by means of the source switch SK2. The trigger signal is then passed to the base of transistor TS908 by means of the coupling switch SK3. With this switch set to DC, the coupling is direct so that there is no bandwidth limitation.
In the LF setting of SK3 the signal is coupled via C909, C911 and the low pass filter which consists of R938 and C913. This filter bypasses those frequencies above approximately 1 MHz and below 3 Hz.
With SK3 at HF, coupling is via C912 which blocks those frequencies below approximately 2 kHz.
TS908 is an emitter follower whose output is connected via diode GR901, to the slope switch SK4. A second emitter follower (TS909) is controlled by the LEVEL potentiometer R1 in order to set a d.c. level which is also connected to the contacts of the slope switch SK4. The LEVEL control range may be extended by a factor of 5 by operation of the 'PULL FOR x5' switch SK5, which causes R942 to be connected in parallel with R943. The d.c. level obtained from TS909 is used to determine the exact point at which the multivibrator is triggered.

The outputs obtained from emitter followers TS908 and TS909 provide inputs to the difference amplifier formed by TS911 and TS914. The inputs to this difference amplifier may be changed over by operation of switch SK4 and this facility enables triggering to be effected on either the positive-going or negative-going edge of the input signal. The amplitude of the input signal is limited by diodes GR903 and GR904, which are connected in anti-parallel across the input contacts of switch SK4. The resulting signals on the collectors of TS911 and TS914 are opposite in polarity, and are applied to the trigger multivibrator (Schmitt-trigger) which is formed by transistors TS912 and TS913. When driven by the difference amplifier, the trigger multivibrator produces a square wave output of constant amplitude, whose relationship to the trigger input is determined by the LEVEL potentiometer R1.

**d. Differentiator stage**

The constant amplitude square wave output taken from the trigger multivibrator output transistor TS913 is applied to the differentiator stage which comprises C915, TS916 and TS917.
The positive-going edges of the input signal are differentiated by means of transistor TS916 and are used to control the auto circuit (see para **j**). Differentiation of the negative-going edges is effected by transistor TS917, whose output forms part of the waveform which drives the sweep gating multivibrator.

**e. Sweep gating multivibrator**

The sweep gating multivibrator is formed by transistors TS922 and TS923 which are connected as a Schmitt-trigger, the base of TS923 being the input terminal.
The output of this circuit is connected to transistors TS934 and TS935 of the integrator circuit. These transistors are used to obtain rapid fly-back of the time base sawtooth voltage (see para **f**).
If the sweep gating multivibrator output is at its minimum positive level, transistor TS934 of the integrator circuit is cut off. The particular time capacitor connected into the circuit by means of the TIME/div switch SK7 is therefore charged by a linearily-increasing voltage and a main sweep is initiated.
This condition of the multivibrator (i.e. output at minimum positive level, causing a main sweep) is termed the 'set' condition.
With the sweep gating multivibrator in its other condition (output at maximum positive level) the time capacitor connected via switch SK7 is totally discharged due to TS934 and TS935. No sweep is therefore generated and this state of the sweep gating multivibrator is termed the 'reset' condition.
Assuming the Schmitt-trigger to be in the reset condition, the input signal must fall to a given switching level in order to change the Schmitt-trigger to its 'set' state. Subsequent excursions of the input to this given switching level will not affect the Schmitt-trigger. However, if the input signal rises to another given switching level the Schmitt-trigger will reset. The Schmitt-trigger will then not revert to its 'set' state until the input voltage again falls to the 'set' switching level.
The two (set and reset) switching levels are disposed about a nominal +3 V level known as the 'set ready' level. The potential between the 'set' and 'reset' levels is termed hysteresis.
The sweep gating multivibrator control waveforms are developed by various combinations of the following four sources:
- The trigger pulse train obtained from the transistor TS917
- The d.c. level determined by the stabilization potentiometer R1036 and applied by transistor TS927.
- The auto circuit output applied via TS927.
- The hold-off circuit output, also applied via TS927.

The particular number of the above-listed waveforms which are summed in order to produce the required input signal for the sweep gating multivibrator is determined by the setting of the AUTO/TRIGG/SINGLE switch SK1.

**Note:** The relationship between the various waveforms which control the sweep gating multivibrator is somewhat complex. The circuits from which the waveforms originate are therefore discussed prior to a detailed description of the sweep gating multivibrator control functions, given in para **k** (operation of the main time-base).

**f. Integrator circuit**

The integrator circuit is a section of the main time-base in which a linearly-increasing voltage is developed by means of the two voltage regulation transistors TS936 and TS941. These transistors cause a constant current to be passed through the particular resistor which has been selected by the setting of the TIME/div. switch SK7. The exact value of the current which passes through the selected resistor depends upon the voltages obtained from transistors TS936 and TS941 and upon the value of the selected resistor.

The voltage derived from transistor TS941 (and consequently the current through the selected resistor) is normally constant unless the TIME/div. control is moved from its CAL position.
In this circumstance, the switch SK8 is opened and potentiometer R2 of the TIME/div. control may be used to adjust the voltage supplied by TS941.
The base bias of TS936 is set by means of potentiometers R1049 and R1052 which are each connected between the +24 V line and earth. These potentiometers therefore provide an accurate means by which the current flowing through the selected resistor may be adjusted.
The current flow developed by means of TS936 and TS941 is used to charge a time capacitor which is also selected by the TIME/div. switch.
Since the current source maintains a constant value, the voltage across the capacitor remains a linear increase throughout the charging period. The farther the TIME/div. potentiometer control is advanced from its CAL position, the lower becomes the rate of voltage increase across the capacitor.
Immediately the voltage across the selected time capacitor attains a given value, the hold-off circuit provides a level which is applied to the sweep gating multivibrator via transistor TS927. This causes the sweep gating multivibrator to change to its 'reset' state, i.e. the output at the collector of TS922 is raised to its maximum positive level. Transistor TS935 switches hard on, and this causes the capacitor to rapidly discharge. At the same time the current from TS936 is short-circuited to mass by TS934. It can therefore be seen that a sawtooth waveform is developed across the time capacitor.
A further sawtooth sweep will be generated when the sweep gating multivibrator changes to its 'set' condition. The sweep waveform taken from the capacitor is applied to the base of the emitter follower TS937, the output of which is fed to the base of TS938.
The main sweep waveform present at the emitter of TS938 is fed to the following points:
- To the output socket BU11 by way of transistor TS951
- To the comparator circuit in order to initiate the delayed sweep (if required)
- To the hold-off circuit in order to effect the ultimate discharge of the integrator capacitor upon completion to a sweep

The main sweep waveform is also connected to the horizontal output amplifier, provided that the MAIN TB/DEL'D TB/EXTERN switch SK10 is set to MAIN TB.
The 23 position MAIN TIME BASE TIME/div. switch SK7 provides a total of 23 calibrated deflection coefficients ranging from 1 s/div. to 0,05 μs/div. The following table lists the components chosen for each of the 23 TIME/div. settings:

**Components selected by the TIME/div. switch SK7**

| *TIME/div. setting* | *Main time-base capacitor between points A and B* | *Resistor between G and C* | *Hold off capacitor between points A and H* | *Connection (DE or DF)* |
|---|---|---|---|---|
| 1 s/div. | C871 | R871 + R877 | C877 | DF |
| 0.5 | C871 | R876 | C877 | DF |
| 0.2 | C871 | R874 | C877 | DF |
| 0.1 | C871 | R873 | C877 | DF |
| 50 ms/div. | C871 | R872 | C877 | DF |
| 20 | C871 | R884 | C877 | DF |
| 10 | C871 | R883 | C877 | DF |
| 5 | C871 | R882 | C877 | DF |
| 2 | C876 | R874 | C882 | DE |
| 1 | C876 | R873 | C882 | DE |
| 0.5 | C876 | R872 | C882 | DE |
| 0.2 | C876 | R884 | C882 | DE |
| 0.1 | C876 | R883 | C882 | DE |
| 50 μs/div. | C876 | R882 | C882 | DE |
| 20 | C874 | R884 | C881 | DE |
| 10 | C874 | R883 | C881 | DE |
| 5 | C874 | R882 | C881 | DE |
| 2 | C873//C885 | R884 | C879 | DE |
| 1 | C873//C875 | R883 | C879 | DE |
| 0.5 | C873//C875 | R882 | C879 | DE |
| 0.2 | C872 | R881 | C878 | DE |
| 0.1 | C872 | C879 | C878 | DE |
| 0.05 | C872 | R878 | C878 | DE |

**g. Hold-off circuit**

The output waveform obtained from the integrator circuit is connected to the hold-off circuit via diode GR908. This diode only passes that portion of the waveform which is above the level of the bias potential present at its cathode.
The signal passed by GR908 is applied to the base of transistor TS928 which is connected as an emitter follower whose emitter circuit includes the hold-off capacitor. The particular value of this capacitor is determined by means of the TIME/div. switch SK7 (see points H and A on the main time-base circuit diagram, Fig. XIV-11).
The potential at the emitter of TS928 is used to control the Schmitt-trigger multivibrator formed by TS924 and TS929. In order to clarify the following description, the hold-off multivibrator states are defined as follows.

- High positive output (i.e. the condition which disables the integrator) is termed the 'reset' condition
- Low positive output (i.e. the output which enables the integrator) is termed the 'set' condition

A low input level at the base of emitter follower results in a low output at the collector of the multivibrator transistor TS924 (i.e. the multivibrator is set).
The hold-off multivibrator is powered by means of a current source circuit (transistor TS931) which is part of the single sweep stage.

If the input to the base of transistor TS928 rises above the emitter potential, the transistor will conduct. The emitter voltage of this transistor therefore rises and the hold-off capacitor is charged.
When the base potential falls to the level at which conduction ceases, the emitter voltage of TS928 is held to the potential across the hold-off capacitor. This capacitor discharges through resistor R1029 and this causes the trailing edge of each pulse at the emitter of TS928 to be considerably lengthened.
The trailing edge of each pulse present at the emitter of TS928 is therefore longer than the integrator pulse from which it is originated.

With the oscilloscope operating in the automatic or trigger mode (switch SK1 set to AUTO or to TRIGG) the base potential at TS928 will fall at the same rate as the integrator output waveform: the level to which it may fall is set by the potential divider formed by resistors R1032 and R1033 which are connected in series between earth and a −24 V supply, via switch SK1. In all cases, the leading edges obtained from the integrator will have a sufficiently high level to produce a 'reset' potential at the base (and hence the emitter) of TS928.
When the level of the input signal from the integrator falls to the 'set' level, the hold-off capacitor has the effect of lengthening the trailing edge of the pulse, as previously described. The appearance of the 'set' level at the emitter of TS928 is therefore delayed by a time which is determined by the value of the selected hold-off capacitor. When the hold-off multivibrator is eventually transferred to its 'set' state, the sweep gating multivibrator is provided with a 'set ready' condition via transistor TS927.
The time during which the hold-off multivibrator is its 'reset' condition is termed the hold-off condition. In this condition the integrator circuit cannot be driven. Hold-off time is dependent upon the value of the hold-off capacitor and is always slightly longer than trailing edge of the integrator pulse. This delay allows the integrator circuit to return to its initial state, and correct shaping of the subsequent waveform is ensured.

**h. Reset circuit**

If the AUTO/TRIGG/SINGLE switch SK1 is set to SINGLE, the −24 V bias supply is disconnected from the cathode of diode GR908 in the hold-off circuit. The bias at the base of TS928 is therefore raised slightly, and the emitter voltage is thus prevented from falling below its 'set' level. In this circumstance, the reset circuit must be used in order to trigger the hold-off multivibrator to its 'set' state.
Operation of the reset circuit SET READY switch SK6 results in an earth connection being applied to the bias network of TS931 which is the current source for the hold-off multivibrator. This blocks the current supply to the hold-off multivibrator so that a 'set' state is produced.
The low positive output gives a 'set ready' condition to the sweep gating multivibrator by means of transistor TS927. With the circuit in this condition, the sweep gating multivibrator will be switched by the first super-imposed trigger pulse to be generated by the differentiator.

The integrator is consequently made to produce one pulse. This pulse causes the hold-off circuit to reset. The high bias voltage at the base of TS928 prevents a consequent setting of the hold-off multivibrator. The circuit will not therefore be operable after the completion of the single triggered sweep.
A further single sweep can be displayed only after the SET READY switch SK6 is operated.
Visual indication of the oscilloscope being in the single sweep set ready condition is provided by lamp LA3 which is incorporated in the SET READY switch button. When the AUTO/TRIGG/SINGLE switch SK1 is set to its SINGLE position, lamp LA3 is connected to the collector of transistor TS926.

Provided that the hold-off multivibrator is ready to receive a reset pulse (collector of TS929 positive) TS926 will conduct causing LA3 to be illuminated. Immediately the single sweep has taken place, the low positive potential at the collector of TS929 (hold-off multivibrator) causes TS926 to be cut off so that LA3 is extinguished.

**i. External triggering**

With the X DEFL switch SK10 is set to EXTERN via $Y_B$, the current source transistor TS931 is cut off due to earth connection which is then applied. This causes the hold-off multivibrator to be reset (i.e. a high positive output at the collector of TS924). The high level output at the collector of TS924 is fed via TS927 to the sweep gating multivibrator, whose condition will then maintain TS934 in a conductive state. The time capacitor connected into the circuit by means of the TIME/div. switch SK7 therefore remains discharged, and no integrated pulses can be produced. Reference to Fig. XIV-13 will show that the integrator is not connected to the horizontal output amplifier whilst the X DEFL switch is set to EXTERN via $Y_B$.

**j. Auto circuit**

When the AUTO/TRIGG/SINGLE switch SK1 is set to AUTO, one of two possible levels of d.c. bias is applied to the cathode of diode GR909. The d.c. level is passed to the base of transistor TS927 and therefore influences the sweep gating multivibrator control waveform.
The lower d.c. level causes the hold-off circuit to drive the sweep gating multivibrator in order to develop a trace in the absence of an input signal to the oscilloscope. The high level is produced when an input signal causes the differentiator to operate, positive trigger spikes are than passed to transistor TS918.
The high level has no effect upon TS927 so that oscilloscope continues to function as if it were in the trigger mode. This high level is caused initially by a positive spike from TS916 of the differentiator circuit.
After being inverted by transistor TS918, the pulse is used to switch on TS919 and there is a resultant voltage drop developed across the potential divider formed by R983 and R986. The voltage across R986 causes TS921 to conduct so that current flows through resistors R981 and R982. The voltage across R981 maintains TS919 in its conductive state after the decay of the input pulse from the differentiator.
With both TS919 and TS921 in a state of conduction, the circuit prevents a low impedance which enables capacitor C924 to be discharged.
When C924 is discharged, the current via R988 is too low to maintain TS919 and TS921 in the conductive state. Provided there is a continued supply of trigger pulses from the differentiator, C924 cannot be charged, so that TS927 is biased in such a way that the input of the sweep gating multivibrator only is activated by trigger pulses (via TS917).
If the differentiator circuit is not being driven, no positive spikes will be received from the differentiator. Transistors TS919 and TS921 are therefore cut off and capacitor C924 is charged via R988.
The base potential of TS927 is consequently lowered and this causes the hold off-circuit output waveform being shifted to a level at which it will drive the sweep gating multivibrator.

**k. Operation of the main time-base**

*Triggering*

When a suitable input signal is applied to channel A or channel B of the oscilloscope, trigger signals are produced by the trigger pick-off stage. The particular trigger signal (channel A, channel B, or external) used to drive the main time-base is selected by means of the YA/YB/EXT source switch SK2. When the oscilloscope is operating in the differential mode, the trigger signal obtained from channel A is the difference signal.
Trigger signals applied to the trigger multivibrator of the main time-base are compared to a d.c. level which is determined by the LEVEL potentiometer R1, so that the display may be started from any point on the waveform.
Switch SK4 may be used to invert the polarity of the trigger signal, and this facility enables triggering on both the positive-going and negative-going edges of the input signal.

*Auto circuit*

Trigger signals cause a constant amplitude square wave output to be produced by the trigger multivibrator. This square wave output is passed to the differentiator. The resulting positive-going spikes are applied to the auto circuit in order to prevent the hold-off circuit from driving the sweep gating multivibrator. Note that the auto circuit is inoperative if the AUTO/TRIGG/SINGLE switch is at its TRIGG or SINGLE setting.

*Sweep gating multivibrator control*

The negative-going spikes obtained from the differentiator are superimposed upon the hold off waveform in order to form the sweep gating multivibrator control signal. This control signal has a d.c. level such that only those trigger spikes which are superimposed upon the lower level of the hold off waveform (termed the 'set ready' level) can influence the sweep gating multivibrator.
When a negative-going trigger spike exceeds the lower switching level, the sweep gating multivibrator will be switched to its 'set' state and a main sweep is initiated in the integrator circuit. Subsequent trigger spikes will not affect the formation of the main sweep. At a predetermined amplitude of sweep voltage, the main sweep is terminated by the action of the hold-off circuit and a hold-off period is initiated, a further sweep cannot then be started by a trigger spike until the hold-off waveform has returned to its 'set ready' level.
If the auto circuit is in operation whilst no input signals are present in the oscilloscope, the level of the hold-off circuit output is reduced to such an extent that it traverses both the 'set' and 'reset' input levels of the sweep gating multivibrator. The sweep gating multivibrator (and hence the integrator circuit) becomes free running due to the drive provided by the hold-off circuit. The resulting sweep waveform produces a horizontal trace on the screen. Immediately trigger signals are present, the auto circuit ceases to have any effect upon the hold-off circuit output.

*Single sweep displays*

When the oscilloscope is operating in the single sweep mode (switch SK1 set to SINGLE) the lower level of the hold-off multivibrator input waveform is raised above the lower hysteresis level due to the removal of the −24 V bias supply from the base of TS928. Pressing the 'SET READY' button then causes the hold-off multivibrator to be blocked and its output is therefore raised. The sweep gating multivibrator output is therefore held above the hysteresis gap.
Transistors TS934 and TS935 of the integrator circuit are saturated so that the time capacitor is not charged. Release of the 'SET READY' button results in the sweep gating multivibrator input waveform being lowered to the 'set ready' level. If the sweep gating multivibrator is then switched by a negative trigger pulse, a main sweep is initiated.
The hold-off multivibrator is switched over when the sweep voltage exceeds a predetermined potential.
The main sweep is then terminated.
The hold-off circuit input waveform is prevented from falling below the hysteresis gap, and the sweep gating multivibrator input level is consequently held at its higher level. A subsequent sweep cannot therefore be initiated.

## 2. Delayed time-base

### a. Introduction

The trigger signals derived from the trigger pick-off stage (U25) are applied to the delayed time-base trigger amplifiers which are located on unit 11. An additional circuit on unit 11 is for trigger source signals which are connected to the oscilloscope via the delayed time-base TRIGG socket BU2. The selected trigger signal (channel A, channel B, or external) is applied via the coupling switch SK2, to the pulse shaping circuits of the delayed time-base.

### b. Trigger amplifiers

The following circuit description applies to the trigger amplifiers of channel A and channel B. Since these two amplifiers are identical, only that of channel A is described.
The channel A signal (or the A—B signal if the oscilloscope is operating in the differential mode) taken from the trigger pick-off stage is applied to the base of transistor TS701. The emitter potential of this transistor is held constant by TS702, and its base bias is set by preset potentiometer R701. The output of this trigger amplifier is connected to the contacts of the delayed time-base trigger source switch SK16.
External trigger signals connected to the oscilloscope by way of the delayed time-base TRIGG socket BU2 are passed to two emitter followers (TS706 and TS707). The network which couples BU2 to the base of TS706 includes capacitor C708 which is shorted if the coupling switch SK3 is set to DC.
The network presents a constant input impedance of 1 MΩ in parallel with 20 pF, and affords protection against high input voltages.

**c. Trigger multivibrator**

The particular signal to be used to drive the trigger multivibrator of the delayed time-base is selected by means of the source switch SK16. The trigger signal is then passed to the base of transistor TS708 by means of the delayed time-base coupling switch SK17. With this switch set to DC, the coupling is direct, so that there is no bandwidth limitation. In the LF setting of SK17 the signal is coupled via capacitors C709 and C710, and the low-pass filter which consists of R738 and C712. This filter bypasses those frequencies above approximately 1 MHz and below 3 Hz. With SK17 at HF, coupling is via C711 which blocks frequencies which are below approximately 2 kHz.
TS708 is an emitter follower whose output is connected to the delayed time-base slope switch SK18.
A second emitter follower (TS709) is controlled by the delayed time-base LEVEL potentiometer R9 in order to set a d.c. level which is also connected to the contacts of the slope switch SK18. The LEVEL potentiometer control range may be extended by a factor of 5 by operation of the delayed time-base 'PULL FOR x5' switch SK19, which causes R742 to be connected in parallel with R743. The d.c. level obtained from TS709 is used to determine the exact point at which the multivibrator is triggered.

The outputs obtained from the emitter followers TS708 and TS709 provide inputs to the difference amplifier which is formed by TS713 and TS717, and whose operation depends upon the 'AFTER DELAY TIME' switch SK15 being set to its TRIGG position. The inputs to this difference amplifier may be changed over by operation of switch SK18 and this facility enables triggering to be effected on either the positive-going or negative-going edge of the input signal. The amplitude of the input signal is limited by diodes GR702 and GR703, which are connected in anti-parallel across the input contacts of switch SK18. The resulting signals on the collectors of TS713 and TS717 are opposite in polarity when the circuit is in operation, and are applied to the trigger multivibrator (Schmitt-trigger) which is formed by transistors TS714 and TS716.
When driven by the difference amplifier, the trigger multivibrator produces a square wave output of constant amplitude, whose relationship to the trigger input is determined by the LEVEL potentiometer R9.
If the 'AFTER DELAY TIME' switch SK15 is set to its STARTS position, the −24 V line to the difference amplifier circuit is interrupted and the difference amplifier is therefore blocked.

**d. Differentiator stage**

The constant amplitude square wave output taken from the trigger multivibrator output transistor TS716 is applied to the differentiator stage which includes TS718 and C721. The positive-going spikes are bypassed to earth by diode GR707, and the negative-going spikes are applied to the delayed time-base sweep gating multivibrator TS719 and TS721. Since the differentiator is driven from the trigger multivibrator, the negative-going spikes will only be present when the AFTER DELAY TIME switch SK15 is set to its TRIGG position.

**e. Sweep gating multivibrator**

With the AFTER DELAY TIME switch set to TRIGG, the negative-going differential spikes obtained from TS718 are combined with the hold-off circuit output in order to produce the control waveform for the delayed time-base sweep gating multivibrator. This multivibrator is formed by transistors TS719 and TS721 which are connected as a Schmitt-trigger. An additional transistor (TS720) whose base bias is set by the potential divider R793 and R794, acts as a current source for the Schmitt-trigger. The current source enables the sweep gating multivibrator to operate as a distinct level detector so that intermediate steps present in the control waveform do not appear at the collector of TS719.
The resulting unblanking waveform does not, consequently, contain any distortion which might cause unwanted intensification of the display. In addition to the unblanking waveform, the sweep gating multivibrator of the delayed time-base also supplies a waveform which drives the integrator circuit.
This signal is taken from the collector of TS721 and applied to the bases of transistors TS726 and TS733.
If the integrator control waveform is at its minimum positive level, TS726 and TS733 are cut off. The particular time capacitor connected into circuit by the delayed time-base TIME/div. switch SK11 is therefore charged by a linearily-increasing voltage and a delayed sweep is initiated.
This condition of the multivibrator (i.e. output of TS721 at its minimum positive level, causing a delayed sweep) is termed the 'set' condition.
With the delayed time-base in its other condition (output at maximum positive level) the time capacitor connected via the delayed time-base TIME/div. switch SK11 is totally discharged by TS726 and TS733. No delayed sweep is therefore initiated and this state of the sweep gating multivibrator is termed the 'reset' condition.

Assuming the Schmitt trigger to be in its 'reset' condition, the input signal must fall to a given switching level in order to change the Schmitt trigger to its 'set' state. Subsequent excursions of the input to this given switching level will not affect the Schmitt trigger. However, if the input signal rises to another given switching level, the Schmitt trigger will reset. The Schmitt trigger will then not revert to its 'set' state until the input voltage again falls to its 'set' switching level.
The two (set and reset) switching levels are disposed about a nominal +3 V level known as the 'set ready' level. The potential between the 'set' and 'reset' levels is termed hysteresis.
The input voltage which controls the sweep gating multivibrator is developed by combining the following sources:

- The trigger pulse train obtained from transistor TS718
- The d.c. level determined by the stabilization potentiometer R807 and applied by transistor TS722
- The hold-off circuit output, also applied via TS722
- A d.c. level obtained when the AFTER DELAY TIME switch SK15 is set to its STARTS position

The particular waveform combination and its level is determined by the setting of the AFTER DELAY TIME switch SK15. The trigger pulse train is not produced, and the level of the hold-off pulse is reduced, when SK15 is set to its STARTS position.

**f. Integrator circuit**

The integrator circuit is a section of the delayed time-base in which a linearily-increasing voltage is developed by means of the two voltage regulation transistors TS727 and TS728. These transistors cause a constant current to flow through the particular resistor which has been selected by the setting of the delayed time-base TIME/div. switch SK11. The exact current which passes through the selected resistor depends upon the voltages obtained from TS727 and TS728, and upon the value of the selected resistor.
The voltage derived from TS728 (and consequently the current through the selected resistor) is normally constant unless the TIME/div. control is moved from its CAL position. In this circumstance, the switch SK12 is opened and potentiometer R5 of the TIME/div. control may be used to adjust the voltage supplied by TS728. The base bias of TS727 is set by means of potentiometers R819 and R824 which are each connected between the +24 V line and earth. These potentiometers therefore provide an accurate means by which the current flowing through the selected resistor may be adjusted.

The current flow developed by the circuit which includes TS727 and TS728, is used to charge a time capacitor which is also selected by the TIME/div. switch of the delayed time-base. Since the current source maintains a constant value, the voltage across the time capacitor remains a linear increase throughout the charging period. The farther the TIME/div. potentiometer is advanced from its CAL position, the lower becomes the rate of voltage increase across the time capacitor.
Immediately the voltage across the time capacitor attains a given value, the hold-off circuit provides a level which is applied to the sweep gating multivibrator via transistor TS722. This causes the sweep gating multivibrator to change to its 'reset' condition, i.e. the output at the collector of TS721 is raised to its maximum positive level. Transistor TS726 switches hard on, and this causes the time capacitor to rapidly discharge. At the same time the current from TS727 is short-circuited to mass by TS726. It can therefore be seen that a sawtooth waveform is developed across the time capacitor. A further sawtooth sweep will be generated when the sweep gating multivibrator changes to its 'set' condition.

The delayed sweep waveform present at the emitter of TS731 is fed to the following points:
- Delayed time-base hold-off circuit in order to effect the discharge of the integrator time capacitor upon completion of a delayed sweep (and to hold-off the delayed time-base until the next main time-base sweep is running).
- Horizontal output amplifier, provided that the MAIN TB/DEL'D TB/EXTERN switch SK10 is set to DEL'D TB.

The 23 position DELAYED TIME-BASE TIME/div. switch SK11 provides a total of 22 calibrated deflection coefficients ranging from 0,5 s/div. to 0,05 μs/div., and also enables the delayed time-base to be switched OFF. The following table lists the components chosen for each of the 22 TIME/div. settings:

Components selected by the delayed time-base TIME/div. switch SK11

| *TIME/div. setting* | *Delayed time-base capacitor between points A and B* | *Resistor between G and C* | *Connection (DE or DF)* |
|---|---|---|---|
| 0.5 s/div. | C856 | R862 | DF |
| 0.2 | C856 | R861 | DF |
| 0.1 | C856 | R859 | DF |
| 50 ms/div. | C856 | R858 | DF |
| 20 | C856 | R851 | DF |
| 10 | C856 | R852 | DF |
| 5 | C856 | R853 | DF |
| 2 | C851 | R861 | DE |
| 1 | C851 | R859 | DE |
| 0.5 | C851 | R858 | DE |
| 0.2 | C851 | R851 | DE |
| 0.1 | C851 | R852 | DE |
| 50 μs | C851 | R853 | DE |
| 20 | C852 | R851 | DE |
| 10 | C852 | R852 | DE |
| 5 | C852 | R853 | DE |
| 2 | C853//C857 | R851 | DE |
| 1 | C853//C857 | R852 | DE |
| 0.5 | C853//C857 | R853 | DE |
| 0.2 | C854 | R857 | DE |
| 0.1 | C854 | R856 | DE |
| 0.05 | C854 | R854 | DE |
| OFF | SHORT CIRCUIT | OPEN | DE |

**g. Hold-off circuit**

The delayed time-base hold-off circuit consists of a Schmitt trigger formed by transistors TS723 and TS724. This Schmitt trigger is controlled by a signal obtained from the reset multivibrator (of the main time-base), and by peaks of the delayed sweep voltage which are passed by diode GR709.

When the main sweep voltage exceeds a d.c. level determined by the DELAY TIME MULTIPLIER control, the comparator circuit causes TS933 of the reset multivibrator to conduct. The resulting fall in the hold-off circuit emitter potential reduces the collector potential of TS723 so that the hold-off level present at the emitter of TS722 is removed. This condition of the hold-off circuit (i.e. collector of TS723 at its lower level) is termed the 'set' condition, and its duration is dependent upon the following two factors:
– DELAY TIME MULTIPLIER control setting
– Delayed time-base TIME/div. switch
The maximum possible period in which the hold-off circuit can remain in its set condition is limited by the period of the main sweep.
In the STARTS mode of operation, the delayed sweep commences when the main sweep voltage exceeds a level determined by the setting of the DELAY TIME MULTIPLIER control.
The delayed sweep then continues to rise until its potential exceeds the cathode bias of GR709.
This causes a positive spike to be applied to the base of TS724. The collector of TS723 is then returned to its original (high) condition, and the hold-off circuit is reset. Because of this reset, the emitter potential of the hold-off circuit falls to its lower level (see the waveform relationship diagram of Fig. XIV-12). The emitter potential of the hold-off circuit returns to its high level immediately the main sweep is concluded. The hold-off level present at the emitter of TS722 is therefore maintained until a subsequent main sweep again exceeds the level set by the DELAY TIME MULTIPLIER control.

In the TRIGG mode of operation (AFTER DELAY TIME switch SK15 set to TRIGG) the hold-off circuit is set when the main sweep voltage exceeds the d.c. level determined by the DELAY TIME MULTIPLIER. However, a delayed sweep will not commence unless a trigger pulse appears during the 'set' period of the hold-off circuit. The delayed sweep is terminated in the same way as described for the STARTS mode.

**h. Reset multivibrator**

The reset multivibrator consists of a Schmitt trigger which is formed by TS932 and TS933, and which also includes TS942 connected in common base configuration (this circuit is located on the main time-base unit). Signals obtained from the sweep gating multivibrator and from the comparator are used to control the reset multivibrator, and the resulting output is used to drive the delayed time-base hold-off circuit as described in the previous paragraph.

When no main sweep voltage is being generated by the main time-base integrator circuit, the base of TS932 is supplied with a positive bias. Transistor TS932 is therefore conducting and TS933 is cut off.

There is no emitter current available to the delayed time-base hold-off emitter circuit, due to TS933 being cut off.

At the start of a main time-base sweep, the base bias of TS932 is reduced, although not to the extent which would cause TS933 to conduct. When the main sweep exceeds a level which is determined by the DELAY TIME MULTIPLIER, transistor TS943' of the comparator circuit is cut off. The current which was flowing through TS943' via resistor R1077 is then passed by transistor TS942, to the base of TS933. Transistor TS933 conducts and therefore acts as a current source for the emitters of the delayed time-base hold off circuit.

**i. Comparator circuit**

The comparator circuit includes a differential amplifier (TS943 and TS943') with an associated current source formed by TS947 (this circuit is also located on the main time-base unit).

The function of the comparator circuit is to switch the reset multivibrator in such a way that the delayed time-base hold-off circuit is operable only when the main sweep voltage exceeds the d.c. level set by the DELAY TIME MULTIPLIER potentiometer R4. It therefore initiates a delayed sweep in the STARTS mode of operation, or enables a trigger pulse to start a delayed sweep in the TRIGG mode.

The particular mode of operation is determined by the AFTER DELAY TIME switch setting.

Transistor TS949, whose base bias is set by potentiometer R1094, and transistor TS948, whose base bias is set by potentiometer R1090, act as voltage sources for the DELAY TIME MULTIPLIER potentiometer R4. Potentiometers R1090 and R1094 therefore enable the delay sweep to be set up during adjustment procedures. The d.c. level taken from the wiper of potentiometer R4 is applied, by way of TS938' to the base of TS943'. This causes TS943 of the differential amplifier to remain blocked as long as the main sweep voltage present at its base does not exceed the voltage at the base of TS943'.

When the main sweep voltage at the base of TS943 exceeds the d.c. level applied to TS943', the differential amplifier changes state. Transistor TS943' is therefore blocked and this causes the reset multivibrator to change its state.

**j. Operation of the delayed time-base**

*Introduction*

The comparator circuit, and the reset multivibrator to which it is connected, controls the hold-off circuit of the delayed time-base.

This provides an interlock between the main and delayed time-bases, so that a delayed sweep can only be generated when a main sweep is taking place.

The delayed sweep is used (with the DELAY TIME–BASE switch SK11 in a setting other than OFF) to perform one of the two following functions:

– Intensification of a selected portion of the main time-base display (X DEFL. switch SK10 to MAIN TB)

– Full deflection of a selected portion of the main time-base sweep (X DEFL. switch SK10 to DEL'D TB)

The delayed time-base mode of operation depends upon the setting of the AFTER DELAY TIME switch SK15.

*Delayed time-base triggering*

When a suitable input signal is connected to channel A or channel B of the oscilloscope, trigger signals are produced by the trigger pick-off stage. These trigger signals drive the delayed time-base only if the AFTER DELAY TIME switch is set to TRIGG. In the TRIGG mode of operation, the trigger signal (channel A, channel B, or external) used to drive the delayed time-base is selected by means of the YA/YB/OFF switch SK16.

When the oscilloscope is operating in the differential mode, the trigger signal obtained from channel A is the difference signal.

Trigger signals applied to the trigger multivibrator of the delayed time-base are compared to a d.c. level which is determined by the setting of the LEVEL potentiometer R9, so that the display may be started from any point on the waveform. Switch SK18 may be used to invert the polarity of the trigger signal, and this facility enables triggering on the positive-going and negative-going edges of the signal.

*Operation with the AFTER DELAY TIME switch set to STARTS*

With the AFTER DELAY TIME switch set to the STARTS position, the delayed time-base sweep gating multivibrator is made inoperative and no trigger spikes are presented to the input of the sweep gating multivibrator. The application of a −24 V d.c. bias supply lowers the level of the delayed time-base hold-off circuit output sufficiently to enable the sweep gating multivibrator to be switched by the edges of the hold-off waveform.

*Operation with the AFTER DELAY TIME switch set to TRIGG*

With the AFTER DELAY TIME switch set to TRIGG, signals obtained from the trigger pick-off stage enable the delayed time-base trigger multivibrator to run. The resulting square wave output is differentiated in order to supply a series of negative-going spikes which are used to control the sweep gating multivibrator of the delayed time-base.
If the main time-base is not producing a main sweep, the hold-off circuit of the delayed time-base is blocked. This causes the input of the delayed time-base to be shifted to a level which is high enough to prevent the trigger spikes from having any effect upon the sweep gating multivibrator.
If a main sweep is started, the reset multivibrator will be switched over immediately the sweep voltage exceeds the d.c. level which is set by the DELAY TIME MULTIPLIER potentiometer R4. In the event of the DELAY TIME MULTIPLIER being set at a level which is not exceeded by the main sweep voltage, the reset multivibrator is switched over by an input derived from the integrator of the main time-base.
The reset multivibrator being switched causes the delayed time-base hold-off circuit output to fall to its 'set ready' level. The appearance of a trigger spike will then cause the sweep gating multivibrator to be switched over and a delayed sweep will therefore be initiated. The delayed sweep is terminated when the input from the integrator causes the output of the hold-off circuit to rise.
As the main sweep reaches its peak, the reset multivibrator is switched over so that the delayed time-base is blocked.
Should the main sweep be terminated during the rise of the delayed sweep, the delayed sweep will be terminated immediately.

## F. HORIZONTAL AMPLIFIER

The main time-base, delayed time-base, or the $Y_B$ channel may be chosen as an input source for the asymmetrically-driven push pull horizontal amplifier. The selected signal is applied to the base of TS1103 whose emitter circuit, together with that of TS1102, is fed from the current source stage TS1101. The emitter circuit negative feedback (and hence the deflection sensitivity of the horizontal amplifier) is set by potentiometer R1122.
Closure of relay RE1101, due to operation of the X MAGN PULL FOR x5 switch SK9, causes R1123, R1124 and R1128 to be inserted into the emitter circuit. This results in a decrease in negative feedback by a factor of 5, so that there is a corresponding increase in deflection sensitivity. Whilst relay RE1101 is energized, the MAGN ON indicator lamp is lit to show that the deflection coefficient has been increased.

If the main or delayed time-base has been selected as the input source, a d.c. level is applied to the base of TS1102 in order to set the horizontal trace. Adjustment of the d.c. level is effected by potentiometer R3.
With the X DEFL switch SK10 set to EXTERN via $Y_B$, the PULL FOR x5 switch SK9 is inoperative due to the removal of the +24 V supply.
In this mode of operation, the X POSITION potentiometer R3 is also disconnected from the circuit because horizontal display switching can be effected by means of the Y POSITION potentiometer R17.
The outputs obtained from TS1102 and TS1103 are used to drive the two output sections, TS1175, TS1176, and TS1177 which supplies plate x1 of the cathode ray tube, and TS1178, TS1179, and TS1180 which supplies plate x2.

## G. UNBLANKING CIRCUIT

The unblanking pulses taken from the main and delayed time-bases by way of switch SK10, and the blanking pulses taken from the electronic switch driver via choke L501, are passed to the base of transistor TS1306. This transistor, together with TS1304, forms a cascode amplifier whose output is applied via TS1307 to a low-pass filter (R1320, R1324, R1325, C1305 and C1310). The filter enables the low frequency content of the cascode amplifier output to be fed to the modulator circuit, and also serves to prevent the 25 kHz carrier frequency from reaching the control grid of the cathode ray tube.

The modulator circuit, which is driven from a 25 kHz output taken from the convertor transformer TS1202, is formed by transistors TS1308 and TS1309. The low frequency content of the original waveform appears in a modulated form at the collector of TS1308 and is passed to a demodulation circuit (C1319, R1334, and GR1309) by means of emitter follower TS1309 and capacitor C1311.
The demodulated low frequency output is then mixed with the high frequency content of the original waveform which is present at the junction of R1334 and R1336. The resulting accurate replica of the original waveform is therefore presented at the control grid of the cathode ray tube.
The lower level of the waveform which is passed to the control grid of the cathode ray tube, is clipped by means of diode GR1309. The exact level of clipping is determined by the setting of the INTENS potentiometer which sets the bias of GR1309.

## H. EXTERNAL Z MODULATION

External modulation voltages having either a low frequency or a d.c. component are connected to the Z MOD DC socket BU12 which is located at the rear of the instrument. Inputs to this socket are coupled to emitter followers TS1301 and TS1302. After amplification by TS1303 the signal is fed to the unblanking circuit.
A second socket (Z MOD AC, BU10) enables a.c. modulation signals to be connected via C1316 directly to the cathode of the cathode ray tube.
Socket BU10 is also located at the rear of the instrument.

## I. CATHODE RAY TUBE CURRENT

### 1. Graticule illumination

Two lamps, LA1 and LA2, provide illumination for the graticule.
The lamps are connected in series to form the emitter follower load of transistor TS1228, and their brightness is controlled by means of the ILLUM potentiometer R8.

### 2. Beam correction coils

The toroidal magnetic field produced by winding L1302 enables the beam to be rotated for alignment purposes. The direction and degree of rotation is determined by the setting of potentiometer R1346.
The centre-tapped winding L1301 provides for the adjustment of trace deflection angle and vertical shift. Current flow through the two sections of winding L1301 is controlled by the setting of potentiometers R1343 and R1344.

### 3. Electrode circuits

Brightness control is by means of INTENS potentiometer R6, the control range of which is determined by R1327 and R1328. Focus is controlled by the FOCUS potentiometer R7, and astigmatism is corrected by use of R1341.

## J. POWER SUPPLIES

### 1. General

These consist of a +24 V and +12 V supply, a −24 V and −12 V supply, a rectifier delivering +198 V and −198 V, and a high voltage chopper unit (U7).
The supply transformer is protected with a non-resetting thermal fuse (VL2).
From serialno. DQ1301 onwards the +24 V (+12 V) and −24 V (−12 V) have been modified for better current limitation.
The modified circuit diagram is given in Fig. XIV-15.
For current values see next table.

| *Supply* | *Nominal current* | *Limiting current* | *Short-circuit current* |
|---|---|---|---|
| +24 V | 1,7 A | 2,5 A | 0,5 A |
| −24 V | 0,75 A | 1,3 A | 0,35 A |

In Fig. XIV-16 the detailed circuit of the unmodified sets is given.

### 2. +24 V and +12 V supply

The +24 V output voltage is stabilised with the aid of the long-tailed pair TS1206 and TS1207 so that a part of the output voltage is compared with a reference voltage developed across Z-diodes GR1221 and GR1222. Any difference signal is via TS1201 and TS1202 applied to the series-transistor TS1203.
The current is limited by TS1204 which is controlled by the voltage drop across R1201.
The +12 V supply is reduced from the +24 V by TS1209 and TS1208.

### 3. −24 V and −12 V supply

The −24 V output voltage is stabilised with the aid of a long-tailed pair TS1218 and TS1219 so that a part of the output voltage is compared with a reference voltage developed across Z-diodes GR1213 and GR1214. Any difference signal is via TS1216 and TS1214 applied to the series-transistor TS1213.
The current is limited by TS1217 which is controlled by the voltage drop across R1234.
The −12 V supply is reduced from the −24 V by TS1220, TS1221 and TS1222.

### 4. High voltage chopper unit

This unit delivers +8500 V and −1600 V for the c.r.t., and +90 V and −90 V for the time-base and unblanking circuits (also the c.r.t. filament is fed by an a.c. voltage of 6,3 V from the chopper transformer).
The chopper operates at a frequency of approximately 25 kHz. The oscillator section of the chopper is formed by transistors TS1211 and TS1212, the oscillator transformer TS1202 and capacitor C1205.
Feedback is provided by connecting a winding of the transformer to the base circuits of TS1211 and TS1212.
Via R1248 the 25 kHz signal is applied to the modulator part of the unblanking circuit (see para G).
Parasitic oscillation is suppressed by R1220 (6,8 ohm).
The 1 ohm resistor R1215 serves merely as fuse if the chopper circuit is overloaded.

## K. CALIBRATION VOLTAGE GENERATOR

The calibration source for the oscilloscope is obtained from a free-running multivibrator, consisting of transistors TS1223 and TS1224. A further two transistors (TS1226 and TS1227) are incorporated into the circuit to provide constant current sources.
The base bias of both current source transistors may be adjusted with the aid of potentiometer R1253 in order to set the amplitude of the square wave output. A second potentiometer (R1265) in the collector circuit of TS1223 enables the output frequency to be set at 2 kHz.
The 600 mV square wave output, taken from the emitter of TS1224, is available at the CAL socket BU3 which is located on the front panel beneath the screen bezel.

## L. CIRCUIT DESCRIPTION PM 3250X

### 1. Introduction

This section describes the sync. separator, mains triggering and external horizontal input circuits which are exclusive to the X version of the PM 3250 oscilloscope. The section also details those modifications which have been made to the basic PM 3250 circuits in order to make them suitable for the PM 3250X.

### 2. Sync. separator

Input signals, taken from the contacts of the $Y_A/Y_B$/EXT. switch (SK2) are passed to the gate of field effect transistor TS2103. The source and drain voltages of this field effect transistor are in antiphase and it is therefore used to provide phase reversal. The appropriate switching is performed by means of diodes GR2101 and GR2102: these are opened and closed by a −24 V potential which is controlled by the PUSH FOR − VIDEO switch (SK32).
The selected phase is passed to the emitter follower TS2104 via C2106. The signal is then passed through a further four stages of amplification (TS2106, TS2107, TS2108 and TS2109) in which the unwanted 'white' portion of the signal is clipped by diodes GR2103 and GR2104.

Video field sync. pulses are formed by passing the signal present at the emitter of TS2109 to the integrator circuit formed by R2139, R2142, C2116, C2117, C2118, C2119 and diode GR2108. Note that the operation of the integrator circuit relies upon the reverse resistance of the OA95 diode (GR2108). The output of the integrator is passed to the emitter follower TS2111.

Operation of the PULL FOR TV FRAME switch (SK5) results in a –24 V potential being applied to field effect transistor TS2101 in order to isolate triggering inputs which are normally passed via the contacts of the LF/HF/DC switch (SK3).
At the same time, a –24 V potential opens switching diode GR2107, so that positive-going field sync. pulses from the emitter of TS2111 are coupled to TS908 of the main time-base. LEVEL pot. meter R1 is now out of service, because a d.c. level is generated with the aid of C2114, GR2106, R2108 and R2112.
When the oscilloscope is operating in the mains triggering mode (see para 3) switch SK5 is overriden and TS2101 is cut off. It is therefore impossible to cross-couple field sync. pulses with mains triggering signals.

Line sync. signals are obtained by means of an output taken from the junction of R2137 and R2138 and fed to the base of emitter follower TS2117.
The emitter output of TS2117 is fed to TS708 of the delayed time-base via diode switching circuit (GR2113).

When the PULL FOR TV LINE switch (SK19) is operated, a –24 V supply is connected to the gate of field effect transistor TS2116 so that the normal delayed time-base triggering inputs are isolated.
At the same time, a –24 V potential opens switching diode GR2113 in order to couple line sync. pulses to the base of TS708 of the delayed time-base.
LEVEL pot. meter R9 is now out of service, because a d.c. level is generated with the aid of C2132, GR2116, R2173 and R2178.
Because switches SK5 and SK19 are now used to provide sync. separator output selection, the triggering LEVEL x5 facility is not incorporated in the PM 3250X oscilloscope.

### 3. Mains triggering facility

The main time-base of the oscilloscope may be triggered by means of a mains frequency signal derived from winding S2 of supply transformer TS2101.
The mains frequency signal source is passed through a filtering and attenuation network before being fed to field effect transistor TS2102 which performs a gating function under the control of the PUSH FOR MAINS switch (SK33).

Operation of the PUSH FOR MAINS switch (SK33) causes the mains frequency triggering signal to be coupled to the base of transistor TS908 (main time-base) due to the gating action of field effect transistor TS2102. At the same time, contacts of the PUSH FOR MAINS switch SK33 also complete a pinch-off supply to a second field effect transistor (TS2101) in order to isolate the normal triggering circuit which are connected to the main time-base via the $Y_A/Y_B$/EXTERN and HF/LF/DC switches SK2 and SK3.
In addition to this, the PUSH FOR MAINS switch contacts also interrupt the –24 V control potential for the field sync. output switching diodes so that it is not possible to couple sync. separator outputs whilst the oscilloscope is operating in the mains triggering mode.

### 4. External horizontal input circuit

The external horizontal input circuit consists of a field effect transistor gating stage controlled by means of the X DEFL. switch SK10, and a preamplifier stage. An external horizontal input signal, connected to the oscilloscope by way of the main time-base TRIGG./EXT. X socket BU1, may be used to drive the horizontal output amplifier provided that the X DEFL. switch SK10 is set to its EXTERN position.
This facility, which replaces the EXTERN VIA $Y_B$ function of the basic PM 3250 design, may be used in conjunction with a sweep generator in order to obtain a simultaneous display of two vertical signals.

The two-stage preamplifier circuit, formed by transistors TS2113 and TS2114, provides a x8 gain in order to compensate for signal attenuation in the input stage.

Preset potentiometer R20 which forms part of the horizontal preamplifier circuit, enables the gain to be set within the limits of 1,0 V/div. to 5,0 V/div. (0,1 V/div. to 0,5 V/div. if the MAGN. switch is set to its x10 position).
Trimmer R2152 enables the gain of the amplifier to be calibrated, with R20 set to its fully clockwise position. The output of the preamplifier is connected to the main horizontal amplifier by way of switch SK10 contacts.

Input signals connected to the main time-base TRIGG./EXT. socket BU1 are passed to the preamplifier by means of the gating stage which is formed by field effect transistor TS2112, diodes GR2111 and GR2112, and resistors R2161, R2162, R2163 and R2164. TS2112 is protected against overvoltage with the aid of GR2109.
The gating stage is controlled by means of the X DEFL. switch SK10.

Setting the X DEFL. switch SK10 to its EXTERN position causes a positive potential to be removed from the anode of GR2112 and to be applied to the cathode of GR2111.

This change in bias results in field effect transistor TS2112 being opened so that the signal present at the TRIGG./EXT. X socket is coupled to the preamplifier. At the same time, the preamplifier is connected to the main horizontal amplifier via contacts of the X DEFL. switch SK10.

### 5. Circuit modifications

The following modifications have been made to the basic PM 3250 circuit assemblies in order to make them suitable for the X version:

Added:
- a printed circuit board (U43) containing the various circuits related to the PM 3250X version.
- a pot. meter (R20) mounted at the right-hand side of the cabinet, used as attenuator for the external horizontal amplifier.

Modified:

#### a. Supply unit U1

The following components have been connected across winding S2 of transformer T1201 in order to pick off the mains frequency signal for the mains triggering facility:

a. capacitor C2113, 0,33 $\mu$F ±10 %, 400 V
b. resistor R2106, 120 k$\Omega$, 5 %, CR25
c. 50 $\Omega$ cable to unit U10

#### b. Time-base U10

The values of capacitors C906 and C908 in the TRIGG./EXT. X input circuit are changed as follows:

a. C906 becomes 15 pF
b. C908 becomes 5,6 pF
c. Resistors R742 and R942 (used in the basic PM 3250 to provide the triggering level x5 magnification facility) have been removed.

#### c. Delayed time-base U11 (part of unit U10)

This unit is termed U11X after incorporation of the following modifications:

a. An additional resistor R2167 and field effect transistor TS2116 (part of the delayed time-base trigger gating circuit) have been added.
b. Resistor R741 becomes 11 k$\Omega$, 5 %
c. The printed wiring has been modified as detailed in Fig. XIV-20.

#### d. Main time-base U12 (part of unit U10)

This unit is termed U12X after incorporation of the following modifications:

a. Resistor R941 becomes 11 k$\Omega$, 5 %
b. Resistor R1124 becomes 750 $\Omega$, 1 % (x10 MAGN. modification)
c. An additional resistor R2102 and field effect transistor TS2101 (part of the main time-base trigger gating circuit) has been added.
d. The printed wiring has been modified as detailed in Fig. XIV-19.

#### e. Intermediate amplifier U26

This circuit board assembly has been modified as follows:

- Transistors TS514, TS1151 and TS1152 have been removed.

# X. Dismantling

## A. GENERAL

This section provides the dismantling procedures required for the removal of components during repair operations. All circuit boards removed from the oscilloscope should be adequately protected against damage, and all normal precautions regarding the use of tools must be observed. During dismantling procedures, a careful note must be made of all disconnected leads so that they may be reconnected to their correct terminals during assembly.

> When removing the anode connector of the c.r.t., be sure to discharge both the anode contact of the c.r.t. and the anode connector as well.
>
> **Note:** It takes several seconds for complete discharging of the c.r.t. and the h.t. supply.

To remove the anode connector of the c.r.t., first compress the spring which is concealed beneath the insulation cover. The connector must then be eased upwards and then downwards in order to release the prongs of the spring from the recess in the c.r.t.

Damage may result if the equipment is switched on whilst a circuit board is removed, or if a circuit board is removed before one minute after the oscilloscope has been switched off.

## B. REMOVING THE COVER PANELS AND THE SCREEN BEZEL

The upper and lower cover panels may be removed when four quick-release fasteners, located one in each corner of its panel, are released. When fitting the covers, rotate the fasteners until a click is heard.
The screen bezel may be sprung from its position by pulling at its lower edge. When fitting the bezel, note that its position depends upon whether or not a filter has been incorporated. The correct position is indicated by arrows which are printed on the inner surface of the bezel.

## C. REMOVING THE KNOBS (Fig. X-1)*

The knobs may be removed as follows:

### 1. Single knobs

- Prise of the cap, A
- Loosen the screw (or nut), B
- Pull the knob from its spindle

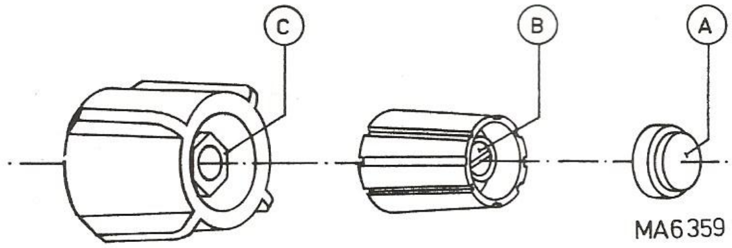



*Fig. X-1. Removing the knobs*

* The INTENS, and FOCUS knobs can simply be pulled-off.

**2. Double knobs**

– Prise off cap A and loosen screw B
– Pull the inner knob from its spindle
– Loosen nut C and pull the outer knob from its spindle

When fitting a knob or cap, ensure that the spindle is in a position which allows reference lines to be coincident with the markings on the panel of the oscilloscope.

**3. Delay time multiplier knob (Fig. X-2)**

– Slacken screw D using an hexagonal key, and pull the knob from its spindle
– Remove the nut E and withdraw the ring from its spindle

When fitting this vernier control, turn the spindle of its potentiometer fully anticlockwise. Place the ring on the shaft so that its reference line corresponds to the zero mark on the calibrated scale then lock it with nut E. Fit the inner knob so that its cam is engaged with the groove of the ring. Turn the inner knob until its zero mark is coincident with the reference line on the ring. Secure the assembly by tightening screw D.

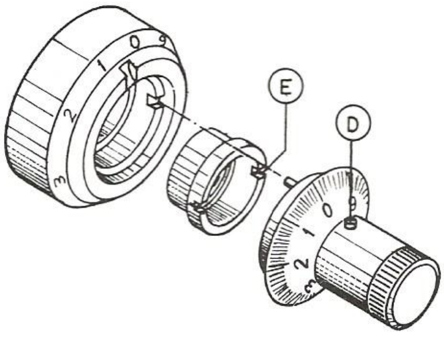



*Fig. X-2. Delay time multiplier vernier knob*

## D. REMOVING THE TIME-BASE UNIT

– Remove the time-base knobs, and unscrew the collars from the X POSITION and LEVEL potentiometers
– Remove the mains cable housing F by unscrewing four screws G, see Fig. X-3

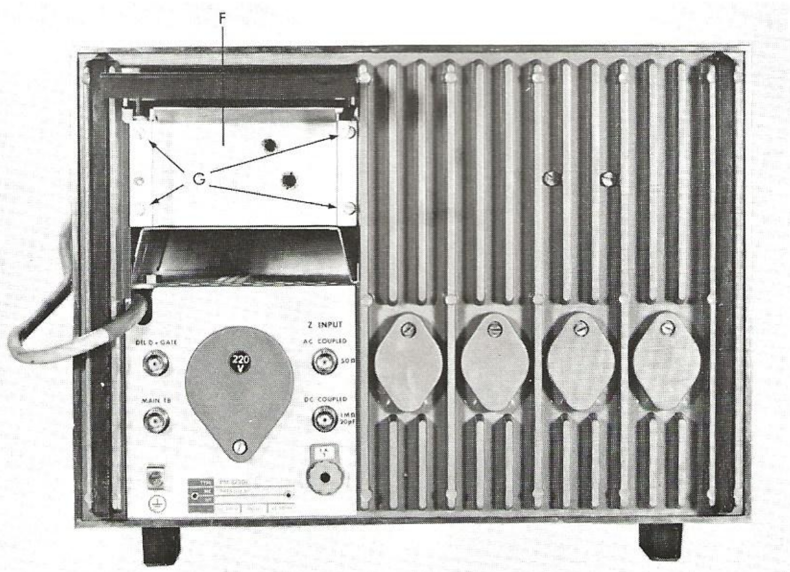



*Fig. X-3. Rear side view*

– Remove five screws which secure the two narrow text plates at the side of the time-base
– Disconnect six coaxial plugs and one wire connector from the underside of the unit
– Disconnect four coaxial plugs and two wire connectors from the top of the unit
– Remove the screw which secures the time-base unit to the front panel of the oscilloscope
– Disconnect the connector socket at the rear of the centre partition. Note that this connector socket can only be withdrawn when its two keyways are compressed sufficiently to release the internal catches
– Tilt the time-base unit at its rear and withdraw it from the oscilloscope

When fitting a time-base unit, its switch toggles should be set to their mid position. The toggles are then easier to insert into their slots.

## E. REMOVING THE INTERMEDIATE AMPLIFIER AND ELECTRONIC SWITCH DRIVER CIRCUIT BOARD (UNIT 26) see Fig. X-4

– Remove relevant channelled base strip I by removing three screws H
– Remove the blue screening cover from the electronic switch driver circuit
– Disengage the switch actuating mechanism
– Unsolder all connecting leads, and disconnect two coaxial leads and two wire connectors carefully noting all disconnecting leads
– Remove the six screws which secure the board

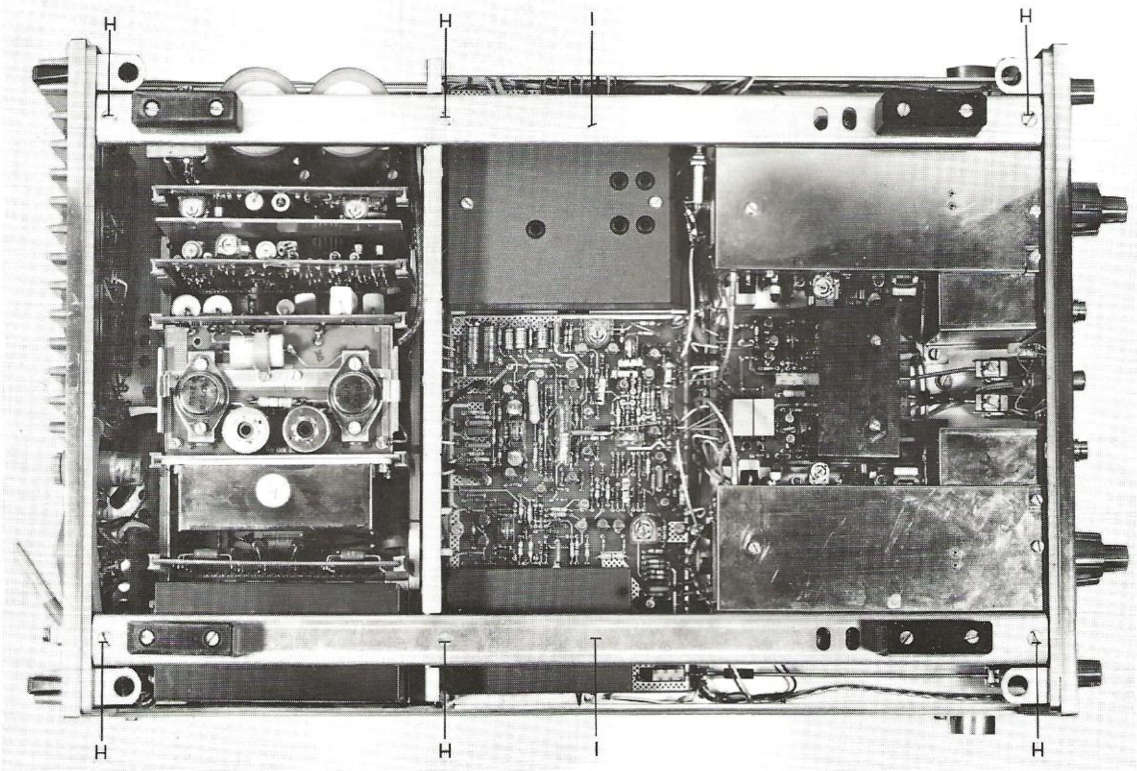



*Fig. X-4. Bottom side view*

## F. REMOVING THE DRIFT REDUCTION AMPLIFIER CIRCUIT BOARD (UNIT 36) see Fig. X-4

– Remove relevant channelled base strip I by removing three screws H
– Remove the blue screening cover from the circuit board
– Disengage the switch actuating mechanism
– Unsolder all connecting leads carefully noting all leads
– Remove the four screws which secure the board

## G. REMOVING THE TRIGGER PICK-OFF STAGE

– Remove the screening cover
– Unsolder all external leads and disconnect four wire connectors carefully noting all leads
– Disengage the switch operating mechanisms
– Remove the four fixing screws

## H. REMOVING THE ATTENUATOR UNITS

– Remove the knobs from the appropriate AMPL control (see para **C**)
– Remove the appropriate channelled base strip I
– Remove four screws in order to free the two screening covers
– Remove two screws which secure the attenuator to the front panel
– Disconnect two coaxial plugs and six wire connectors
– Remove the two screws which attach the attenuator to the base of the oscilloscope. Withdraw the attenuator

When an attenuator is being fitted, care must be taken to ensure that the input socket screen is properly engaged with its fixing clip.

## I. REMOVING THE DELAY LINE (L603), see Fig. X-5

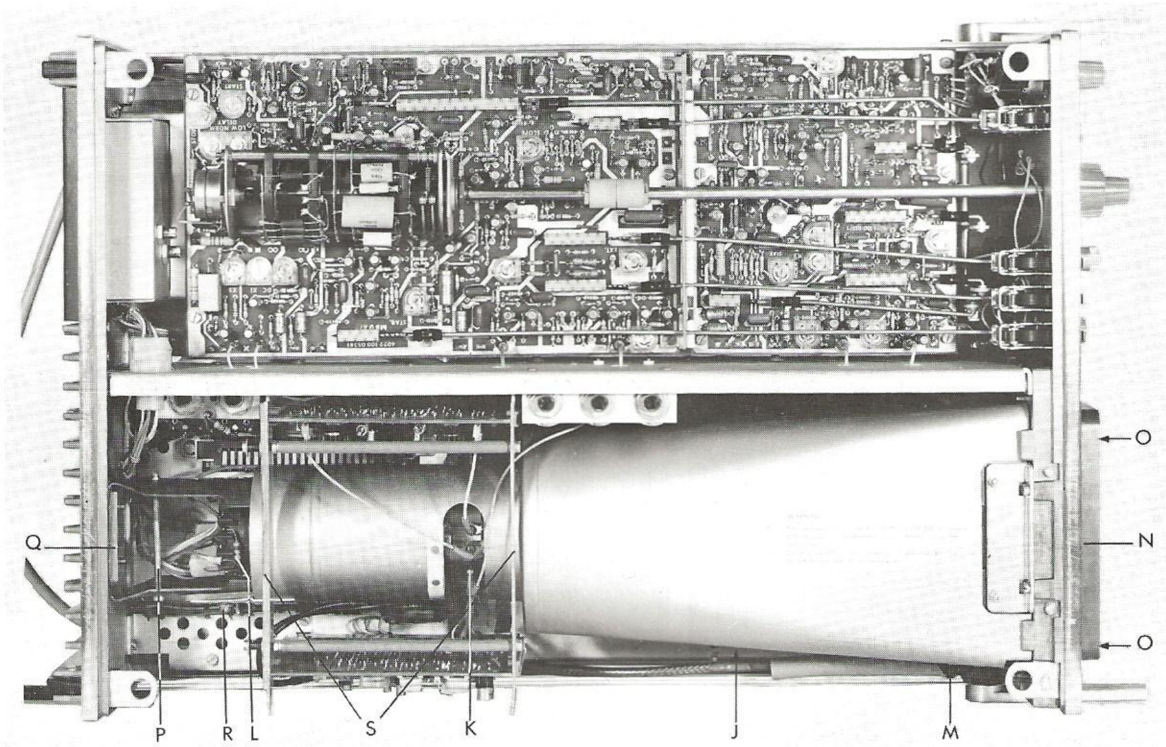



*Fig. X-5. Top side view*

The delay line is located between the c.r.t. and the calibration unit (U9).

– Remove two screws and withdraw the metal delay line bracket J.
– Remove the calibration unit (first remove the securing clip)
– Disconnect the delay line coaxial plugs from the vertical output amplifier and from the intermediate amplifier
– Withdraw the delay line

## J. REMOVING THE POWER SUPPLY UNIT

- Remove the channelled strips I from the bottom side of the oscilloscope
- Disconnect the c.r.t. anode connector

  When removing the anode connector of the c.r.t., be sure to discharge both the anode contact of the c.r.t. and the anode connector as well.

  **Note:** It takes several seconds for complete discharging of the c.r.t. and the h.t. supply.

- Remove the two fixing screws which are adjacent to the electrolytic capacitors, and remove the three fixing screws which are adjacent to the mains transformer. Pull the e.h.t. connector through from the frame
- Partly withdraw the supply unit in order to gain access to the rear side of the mains voltage selector. Unsolder the black lead to the fuse holder and the black lead to the voltage selector.
- Free the voltage selector by removal of its two screws. Withdraw the power supply unit.

When replacing the voltage selector, check that it is fitted in the correct position.

## K. REMOVING THE CATHODE RAY TUBE (Fig. X-5)

- Pull the five connectors K from the pins at the side of the c.r.t.
- Disconnect the socket L from the base of the tube
- Remove the anode connector M from the anode of the tube. To do this compress the spring which is beneath the insulation cover and then ease the connector upwards and downwards in order to release the prongs of the spring from the recess in the c.r.t.

  When removing the anode connector of the c.r.t., be sure to discharge both the anode contact of the c.r.t. and the anode connector as well.

  **Note:** It takes several seconds for complete discharging of the c.r.t. and the h.t. supply.

- Remove the screen bezel N by pulling at its lower edge
- Release the illumination wedges O by removing their securing springs
- Loosen the clamping screw P of the end bracket assembly
- Ease the tube forward taking great care not to engage its side pins with the shield. Unsolder the correction coil leads and then withdraw the tube.
  Note that the bezel and illumination wedges mentioned in the above paragraph must be removed in order to renew defective graticule lamps. When a tube is fitted, the bezel must first be fitted with its 'top no filter' arrow pointing upwards: this allows the face of the tube to be located in its correct position.

## L. REMOVING THE C.R.T. SHIELD (Fig. X-5)

- Remove the c.r.t. as instructed in para K
- Loosen the two screws and plate Q which clamp the c.r.t. bracket to the rear plate
- Remove the screw R and rubber pad by which the shield is attached to the bracket
- Push the screen rearwards so that it may be tilted and then withdrawn. Great care must be taken not to strain any leads whilst the shield is being removed.

When a c.r.t. shield and bracket are being fitted, the screws must not be tightened otherwise the assembly cannot be centralized following the insertion of the c.r.t.

## M. REMOVING THE HORIZONTAL AND VERTICAL OUTPUT AMPLIFIERS (Fig. X-5)

- Pull off the securing bracket S
- Remove two coaxial plugs of the delay line and disconnect the blue and grey leads from the vertical output amplifier.
  Withdraw the vertical output amplifier circuit board.
- Disconnect the orange and yellow leads before removing the horizontal output amplifier

## N. POWER ON SWITCH, INTENS, FOCUS, AND ILLUM POTENTIOMETERS

Access to the POWER ON switch, its associated indicator lamp and the INTENS, FOCUS, and ILLUM potentiometers may be gained upon removal of the c.r.t. and its shield (paras K and L)

## O. POWER TRANSISTORS

The power transistors fitted to the heat sink at the rear of the oscilloscope are plugged-in, and secured by two screws; one of these screws also holds the insulating cover. When fitting a new transistor, care must be taken not to omit the mica washer and the insulating ring (they serve for electric insulation).

# XI. Checking and adjusting

## A. GENERAL

The following information provides the complete checking and adjusting procedure for the /04 versions of the PM 3250 oscilloscope. Because some of the circuits are interdependent, a certain order of checking and adjusting is often required. The procedures are, therefore, presented in a sequence which is best suited to this order and cross-reference is made to any circuit which may influence a particular adjustment. Prior to checking and adjusting a particular circuit, care must be taken to ensure the accuracy of all associated circuits.
The tolerances stated in the checking and adjusting procedures apply only to instruments which are completely adjusted, and may differ from the data given in Chapter SPECIFICATION of this manual.
Only skilled personnel familiar with the risks of shock should perform those adjustments which necessitate the removal of covers from an oscilloscope which is connected to the mains. In all other circumstances, covers should remain fitted as long as the instrument is live.
Check that the position of the voltage selector at the rear of the instrument corresponds to the local mains voltage (check also the correct value of the mains fuse).
In general a preliminary warm-up time of at least one hour is recommended.
Before checking or adjusting any circuit be sure that the instrument is in reasonable working condition.
After adjustment of preset potentiometers do not forget to refit the dust caps.

All preset potentiometers, select-in-test resistors and trimming capacitors are indicated in Fig. XI-8.
All controls mentioned in the 'checking and adjustment' procedure without item numbers, are located on the front panel.
Unless otherwise stated, the front panel controls must set to in following positions:
- Trigger switches of the main time-base to positions: AUTO, $Y_A$, LF and +.
- MAIN TIME BASE switch to 1 ms/div. (cont. control to CAL.).
- X DEFL. switch to MAIN TB.
- DELAY TIME multiplier to 0.
- Trigger switches of the delayed time-base to: STARTS, $Y_A$, LF and +.
- DELAYED TIME-BASE switch to OFF (cont. control to CAL.).
- GAIN switch to: x1
- CHOPP./ALT. switch to: ALT.
- Both AC/0/DC switches to: AC.
- Switch A/OFF/A–B to A.
- Switch B/OFF/–B to OFF.

## B. SUPPLY UNIT

Only the +24 V and –24 V output voltages of the supply unit are adjustable. All other supply voltages are derived from the said voltages, except the + and –198 V.

Required instruments:
- A mains voltage meter
- A d.c. measuring instrument
- If one wants to check the stabilisation properties of the supply unit, moreover, a variable transformer (100 VA) and a high-sensitivity voltmeter (preferably a digital voltmeter) are required.

**Supply voltages**

| *Supply voltage* | *Tolerance* | *Test point* | *Max. perm. ripple voltage* |
|---|---|---|---|
| +12 V | ±0,5 V | Terminal board, blue lead [1] | 2 $mV_{p-p}$ |
| −12 V | ±0,5 V | Terminal board, grey lead [1] | 2 $mV_{p-p}$ |
| +24 V | ±0,1 V | Terminal board, red lead [1] | 2 $mV_{p-p}$ |
| −24 V | ±0,1 V | Terminal board, yellow lead [1] | 2 $mV_{p-p}$ |
| +90 V | ±3 V | Terminal board, purple lead [1] | 0-0,5 $V_{p-p}$ depending on sweep times |
| −90 V | ±3 V | − C1308 unit U3, rear side of board | 0-0,5 $V_{p-p}$ depending on sweep times |
| +198 V | − | + C1211, orange lead [2] | 1 $V_{p-p}$ |
| −198 V | − | − C1208, white lead [2] | 1 $V_{p-p}$ |

[1] Test points on terminal board, located underneath the c.r.t., and behind the delay line and unit U9.

[2] See Fig. XI-1.

**Adjusting the +24 and −24 V**

For test points see table above.
Adjust R1208/U2 for +24 V.
Adjust R1242/U2 for −24 V.

**Mains voltage influence**

Vary the mains voltage + and −10 % of the nominal value using a variable transformer; the +24 V and −24 V supply variation should be less than 0,1 %

**Power consumption**

Check that the mains current at 220 V mains voltage, 50 Hz does not exceed 550 mA (use a soft-iron meter only).

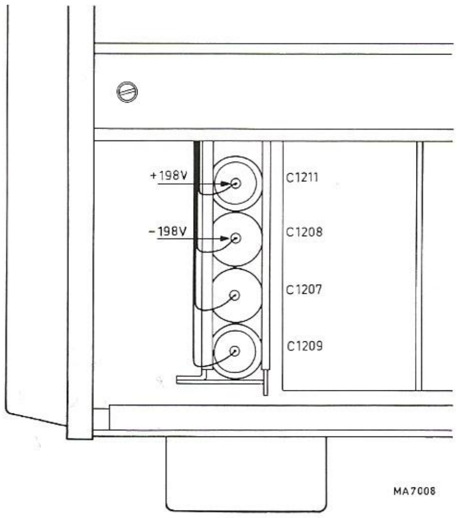



*Fig. XI-1. Measuring the +198 V and −198 V*

## C. CATHODE RAY TUBE CIRCUIT

**Introduction**

In this chapter following checks and adjustments are discussed:
1. Intensity R1327/U9, R1328/U9, (R6)
2. Unblanking (Z-amplifier) C1306/U3, C1307/U3, R1308/U3, R1321/U3
3. Focus and Astigmatism R1337/U9, R1341, (R7)
4. Trace rotation, Orthogonality and Pattern distortion R1346, R1343, R1344, R1339
5. Gain and h.f. response of the vertical amplifier
6. Gain and linearity of the horizontal amplifier and the time-base.

In principle, the above-mentioned points are necessary when the C.R.T. has been replaced; they apply equally to C.R.T. versions −BE/09 and −GM/09.

Required instruments:
A sine wave generator (2 kHz)
A d.c. voltmeter

## 1. Intensity

The control range of the intensity control on the front panel is adjusted with R1327 (+) and R1328 (–) located on calibration unit U9.

**WARNING:** Use a well-insulated trimming tool, as these potentiometers carry 1600 V.

- Both AC/0/DC switches to 0
- A/OFF/A–B switch to OFF
- B/OFF/–B switch to B
- X DEFL. switch to EXTERN via $Y_B$
- Centre the spot with the $Y_B$ POSITION potentiometer
- Rotate potentiometer INTENS. on the front until it is $90^o$ from its fully-anti-clockwise position.
- Adjust R1327 (+) to the position at which the spot is just visible.
- MAIN TIME-BASE switch to 1 ms/div.
- DELAYED TIME-BASE switch to 1 $\mu$s/div.
- X DEFL. switch to DEL'D TB.
- Potentiometer INTENS. fully clockwise.
- Display the beginning of the trace using the X POSITION potentiometer.
- Adjust R1328 (–) to the position at which a dot, at the beginning of the trace, becomes just visible.

Repeat the whole procedure until optimum results are obtained.

## 2. Unblanking (Z-amplifier)

Equal brightness of the trace is adjusted with R1321, C1306 and C1307.

- MAIN TIME-BASE switch to 10 ms/div.
- Check that the trace is of equal brightness throughout.
- Any necessary adjustment can be made with potentiometer R1321 (if necessary change R1325).
- Repeat adjustment of intensity para a and above mentioned adjustment in order to obtain optimum results.
- MAIN TIME-BASE switch to .05 $\mu$s/div.
- Check that the trace is equally bright over the whole length (uniform thickness).
  If necessary, correct with trimmers C1306 and C1307.
- X MAGN. switch to x5 (knob pulled out).
- When the INTENS. potentiometer is turned from max. brightness to the intensity at which the trace is just visible, only the first two divisions of the total trace are allowed to become invisible (if necessary, adjust C1306 and C1307).

## 3. Focus and astigmatism

Focus and astigmatism are adjusted with R7 (front panel) and with R1341 (centre mounting plate) respectively.

- Apply a 2 kHz sine-wave signal (100 mV) to input $Y_A$; set the $Y_A$ AMPL. switch for a six division peak-peak vertical deflection.
- Set the TIME/div. switch of the main time-base and the LEVEL potentiometer to a position which enables several complete cycles to be displayed.
- Set the INTENS. potentiometer on the front for normal brightness.
- Adjust the FOCUS potentiometer in conjunction with ASTIGM. pot. meter R1341 in order to obtain a reasonably sharp clearly - defined trace (check also at minimum and maximum intensity, using R6 and R7 only; if necessary change R1337/U9.

## 4. Trace rotation (R1346), Orthogonality (R1343, R1344) and Pattern distortion (R1339)

These potentiometers are located on the centre mounting plate.

- Both AC-0-DC input switches to 0.
- Both input switches A/OFF/A–B and B/OFF/–B to OFF.
- The potential between the plates of the vertical deflection must now be 0 volt; if not, adjust the vertical amplifier, see chapter D.5.
- R1339, R1343, R1344 and R1346 to mid-position.
- Adjust R1346 so that the trace runs exactly in parallel with the horizontal lines of the graticule; centre the trace with R1343 and R1344.
- A/OFF/A–B switch to A.
- B/OFF/–B switch to B.

– Shift both traces to the horizontal centre-line with the aid of the POSITION potentiometers (during the following of this particular procedure do not readjust these potentiometers anymore).
– AC-0-DC switch of channel A to AC.
– In order to obtain a display useful for orthogonality adjustments, apply a 2 $V_{p-p}$ sine-wave signal (freq. ≈ 2 kHz) to the $Y_A$ input and set $Y_A$ AMPL. switch to 20 mV/div.
– Adjust the orthogonality potentiometers R1343 and R1344 so, that the vertical centre lines of the A-trace run exactly in parallel with the vertical lines of the graticule; the B-trace must remain on the horizontal centre line; also adjust R1346 to obtain a display in parallel with the horizontal lines of the graticule.
– Adjust R1339 (PATT. DIST.) in order to obtain an undistorted display.
– Set the signal generator for a frequency between 100 kHz and 200 kHz, and the $Y_A$ AMPL. switch for a trace height of approximately 8 div.
– If necessary, re-adjust R1339 in order to reduce barrel an pin-cushion effects to minimum.

**5. Gain and h.f. response of the vertical amplifier**

Refer to chapter D.6.

**6. Gain and linearity of the horizontal amplifier and the time-base**

Refer to chapter H.

## D. VERTICAL DEFLECTION

The various checking and adjusting procedures to be applied to the amplifiers and attenuators of channel A and channel B are identical. The following instructions are, therefore, presented for channel A; relevant channel B controls are stated in brackets where applicable.
Separate instruction is given whenever differences arise between versions.
Prior to adjusting the square-wave response of the vertical amplifiers, ensure that the main time-base and horizontal amplifier are operating correctly.
When one or more transistors or other components have been replaced in the vertical amplifiers the h.f. response must be checked.

**1. Pre-amplifiers**

In this chapter the following checks and adjustments are discussed:

a. D.C. balance
b. D.C. symmetry level
c. L.F. response
d. Gain
e. Overshoot compensation of the input attenuators
f. Input capacitance

Required instruments:

A calibrated square-wave generator (10 Hz - 10 kHz)
A d.c. voltmeter (free from earth)

**a. D.C. balance**

The d.c. balance is adjusted with the DC BAL. preset potentiometers on the front panel.
– GAIN switch to x10.
– AMPL. switches to 2 mV/div.
– Both cont. controls of the attenuator to position CAL.

*Channel A:*

– Switch A/OFF/A–B to A.
– Switch B/OFF/–B to OFF.
– Position the trace on the screen with the $Y_A$ POSITION potentiometer.
– Adjust DC BAL. potentiometer R11 so that the trace does not jump when the relevant AC/0/DC switch is switched between the 0 and the DC position.

*Channel B:*

- Switch B/OFF/–B to B.
- Switch A/OFF/A–B to OFF.
- Position the trace on the screen with the $Y_B$ POSITION potentiometer.
- Adjust DC BAL. potentiometer R12 so that the trace does not jump when the relevant AC/0/DC switch is switched between the 0 and the DC position.

Check also the d.c. balance of the drift reduction amplifiers, see chapter 2.

**b. D.C. symmetry level**

This is the symmetry of the balance circuit of the pre-amplifiers (in conjunction with the drift reduction amplifiers); check that the d.c. balance of the pre-amplifiers (point a) is in order.
- AC/0/DC switches to position 0.
- Switch A/OFF/A–B to OFF
- Switch B/OFF/–B to OFF

*Channel A:*

- Connect a d.c. voltmeter (free from earth) between the junctions R137-R138 and R156-R157.
- Change R145 until this voltage is zero (+ or –0,5 V).

*Channel B:*

- Connect a d.c. voltmeter (free from earth) between the junctions R337-R338 and R356-R357.
- Change R345 until this voltage is zero (+ or –0,5 V).

**c. L.F. response**

The l.f. response of the vertical amplifier is adjusted with potentiometer R122 (R322) and R143 (R343) located on the pre-amplifiers.
- MAIN TIME-BASE switch to 20 ms/div.
- Apply a square wave with an amplitude of 300 mV from zero and with a frequency of 10 Hz to the $Y_A$ (or $Y_B$) input.
- Set the relevant AMPL. switch to 20 mV (cont. control in position CAL.).
- Both AC/0/DC switches to DC.
- Set the POSITION potentiometer in order to display the earth part of the signal.
- Adjust potentiometer R122 (R322) for a straight top; if necessary, change R123 (R323).
- Decrease the amplitude of the input signal to 30 mV.
- AMPL. switch to position 2 mV/div.
- Adjust the POSITION potentiometer in order to display the earth part of the signal.
- Adjust potentiometer R143 (R343) for a straight top. Check also in positions 5 mV/div. and 10 mV/div. of the AMPL. switch.

**d. Gain**

Channel A or B
The gain of the pre-amplifiers is adjusted with the GAIN ADJ. preset potentiometers R10 and R13 on the front panel.
- GAIN switch to x1.
- Set the relevant AMPL. switch to 0.1 V/div.
- Set the relevant AMPL. fine control to position CAL.
- Connect the CAL. socket to the relevant Y input.
- Set the GAIN ADJ. potentiometer for a trace height of exactly six divisions.
  Check that there is still a measure of control (approx. $30^{\circ}$) left.

If necessary, also the gain of the intermediate amplifier must be adjusted.
Refer to chapter D.3.c.

**e. Overshoot compensation of the input-attenuators**

- MAIN TIME-BASE switch to 50 µs/div.
- Apply a 10 kHz square-wave signal (rise time less than 200 ns) to the desired Y-input socket.
- Adjust the attenuator in accordance with the following table, so that no overshoot occurs:

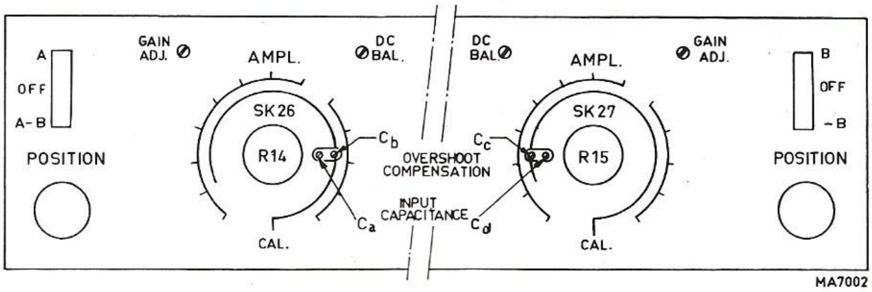



*Fig. XI-2. Input and compensation capacitors*

| *AMPL. switch set at* | *Input voltage* | *Adjust with Cb - (Cc) (see Fig. XI-2)* | | *Trace height required (divs. ±2 %)* |
|---|---|---|---|---|
| 2 mV/div. | 12 $mV_{p-p}$ | C64 (C264) | C108 See note | 6 |
| 5 | 30 | C63 (C263) | (C308) | 6 |
| 10 | 60 | C60 (C260) | | 6 |
| 20 | 120 | C55 (C255) | | 6 |
| 50 | 300 | C52 (C252) | | 6 |
| .1 V/div. | 600 | C48 (C248) | | 6 |
| .2 | 1,2 $V_{p-p}$ | C46 (C246) | | 6 |
| .5 | 3 | C42 (C242) | | 6 |
| 1 | 6 | C39 (C239) | | 6 |
| 2 | 12 | C36 (C236) | | 6 |
| 5 | 30 | C33 (C233) | | 6 |
| 10 | 60 | C29 (C229) | | 6 |
| 20 | 80 | C27 (C227) | | 4 |

**Note:** C108 (C308) for coarse adjustment; C64 etc. for fine adjustment.

Use the trimming rod supplied with the oscilloscope.

**f. Input capacitance**

The input capacitance of the oscilloscope must have the same value for all positions of the input AMPL. switches. This capacitance need not be exactly 20 pF, because a measuring probe can be adjusted to the input capacitance of an oscilloscope.
Preferably both $Y_A$ and $Y_B$ inputs must have the same input capacitance.
The equality of the various input capacitances can be checked and adjusted with e.g. capacitance measuring bridge. The capacitors in following table must be so adjusted that the input capacitance is the same for each position of both AMPL. switches.
If desired a 1 MΩ//20 pF measuring probe or a standardizer 1 MΩ//20 pF (TEK 067 - 538 - 00) can be used, in conjunction with a square-wave generator.
In this case, the capacitors in following table must be so adjusted that no distortion occurs.

| *AMPL. switch set at* | *Input voltage* | *Adjust with Ca - (Cd) See Fig. XI-2* | *Trace height required (divs. ±2 %)* |
|---|---|---|---|
| 2 mV/div. | 12 $mV_{p-p}$ | C61 (C261) | 3 |
| 5 | 30 | C58 (C258) | 3 |
| 10 | 60 | C56 (C256) | 3 |
| 20 | 120 | C53 (C253) | 3 |
| 50 | 300 | C51 (C251) | 3 |
| .1 V/div. | 600 | C47 (C247) | 3 |
| .2 | 1,2 $V_{p-p}$ | C44 (C244) | 3 |
| .5 | 3 | C41 (C241) | 3 |
| 1 | 6 | C38 (C238) | 3 |
| 2 | 12 | C34 (C234) | 3 |
| 5 | 30 | C32 (C232) | 3 |
| 10 | 60 | C28 (C228) | 3 |
| 20 | 80 | C26 (C226) | 2 |

Use the trimming rod supplied with the oscilloscope.

## 2. Drift reduction amplifiers

These circuits are provided with following adjusting possibilities:

a. D.C. balance
b. Chopper signal suppression

### a. D.C. balance

- Set the relevant AMPL. switch on the front panel to 2 mV/div.
- Set the relevant AC/0/DC switch to 0.
- Set the GAIN switch to x10.
- No trace displacement may occur when the AMPL. switch is transferred from 2 mV/div. to 20 mV/div. and back.
  This can be adjusted with potentiometer R1406 (R1419)
  Check also the d.c. balance of the pre-amplifier.

### b. Chopper signal suppression

- Set the relevant AMPL. switch on the front panel to 2 mV/div.
- Set the relevant AC/0/DC switch to DC.
- Set the GAIN switch to x10.
- Set main time-base switch to .5 ms/div.
- The display can be triggered by putting an insulated piece of wire, connected to the trigger input socket, through the indicated hole of the screening plate of the drift reduction circuits.
- Adjust trimmer C1403 (C1422)

Repeat the d.c. balance of both the pre-amplifiers and the drift reduction amplifiers, as well as the chopper signal suppression adjustments in order to obtain optimum results.

## 3. Intermediate amplifier

The intermediate amplifier is provided with the following adjusting possibilities:

a. Shift symmetry
b. Shift range
c. Gain
d. H.F. response
e. EXT. via $Y_B$

Required instrument:

A calibrated sine-wave generator (120 $mV_{p-p}$ - 480 $mV_{p-p}$/2 kHz)

### a. Shift symmetry

- Set the Y AMPL. switches to 20 mV/div. (cont. control to CAL.).
- GAIN switch to x10.
- Both AC/0/DC switches to 0.
- A/OFF/A–B to A.
- B/OFF/–B to B.
- Use both Y POSITION knobs to shift the traces onto the screen.
- When the A/OFF/A–B switch is switched from A to A–B and back the A-trace may not jump more than two divisions.
  If necessary adjust R1623.
- A/OFF/A–B switch to A.
- When rotating the $Y_A$ AMPL. cont. control knob the A-trace may not shift more than 0,4 div.
  If necessary change R1600.
- When the B/OFF/–B switch is switched from B to –B and back the B-trace may not jump more than two divisions.
  If necessary adjust R475.
- B/OFF/–B switch to +B.
  When turning the $Y_B$ AMPL. cont. control knob the B-trace may not shift more than 0,4 div.
  If necessary change R452.

**b. Shift range**

- Both Y AMPL. switches to 20 mV/div.
- GAIN switch to x1.
- A/OFF/A–B switch to A.
- B/OFF/–B switch to OFF.
- Apply a 480 $mV_{p-p}$ 20 MHz sine-wave signal to the $Y_A$ input.
- Check whether the display can be shifted symmetrically over the screen using the $Y_A$ POSITION knob. If necessary change R413 or R418.
- A/OFF/A–B switch to OFF.
- B/OFF/–B switch to B.
- Apply the 480 $mV_{p-p}$ 20 MHz sine-wave signal to the $Y_B$ input.
- Check whether the display can be shifted symmetrically over the screen using the $Y_B$ POSITION knob. If necessary change R486 or R491

**c. Gain**

Gain adjustment is only possible if the l.f. response of the pre-amplifiers is well adjusted (see chapter D1.c.).

- AC/0/DC switches to DC.
- A/OFF/A–B switch to A–B.
- B/OFF/–B switch to OFF.
- GAIN switch to x1.
- Both Y AMPL. switches to 20 mV/div. (cont. control to CAL.).
- Apply a 2 kHz sine-wave signal having an amplitude of exactly 120 $mV_{p-p}$ to the $Y_B$ input.
  The vertical deflection must now be exactly six divisions.
  This can be adjusted with the $Y_B$ GAIN ADJ. screw driver adjustment (at the front) which must be approximately in the middle position.
  If necessary change R455.
- B/OFF/–B switch to B.
  The vertical deflection of the second waveform which appears now must be also exactly six divisions.
  If necessary change R495.
- Remove the signal from the $Y_B$ input and apply it to the $Y_A$ input.
  The vertical deflection must be again exactly six divisions.
  This can be adjusted with the $Y_A$ GAIN ADJ. screw driver adjustment (at the front), which must be approximately in the middle position.
- A/OFF/A–B switch to A.
  The vertical deflection must be exactly six divisions.
  If necessary change R1615 (or R1614).
- GAIN switch to x10.
- A/OFF/A–B switch to A–B.
- Reduce input signal to exactly 12 $mV_{p-p}$.
  The vertical deflection must be exactly six divisions.
  If necessary change R443.

**d. H.F. response**

Refer to chapter D.6.

**e. EXT. via $Y_B$**

Refer to chapter H.d.

**4. Chopper circuit**

This circuit (unit U26a) contains no adjusting points, it may yet be necessary to check the chopper frequency.
This frequency depends on the position of the GAIN switch: x1: 1 MHz
x10: 200 kHz

The frequency can be checked e.g. on the base (R457) of TS424 in the intermediate amplifier.

The frequency may also be checked using the oscilloscope itself, in the following way:

- Connect the $Y_A$ input to the base of TS424.
- A/OFF/A–B switch to A.
- B/OFF/–B switch to B.

– $Y_A$ input AC/0/DC switch to AC.
– $Y_A$ AMPL. switch to .2 V/div.
– MAIN TIME-BASE switch to .5 μs/div.
– Set both POSITION potentiometers for a distance of six divisions between the traces.
– Adjust the LEVEL potentiometer of the main time-base in order to obtain a stable display (remember this is not a conventional way of operating an oscilloscope).

**5. Vertical output amplifier**

This unit is provided with four potentiometers for adjusting the d.c. level.

Required instrument:
A d.c. electronic voltmeter, free from earth.

– AC/0/DC switches to 0.
– A/OFF/A–B switch to A.
– B/OFF/–B switch to OFF.
– Connect the voltmeter as indicated in Fig. XI-3 via 10 kΩ resistors between the emitters of TS601 and TS604 (points 1 and 2 in Fig. XI-4).
– Adjust the $Y_A$ POSITION potentiometer until the voltage is 0 V + or –100 mV.

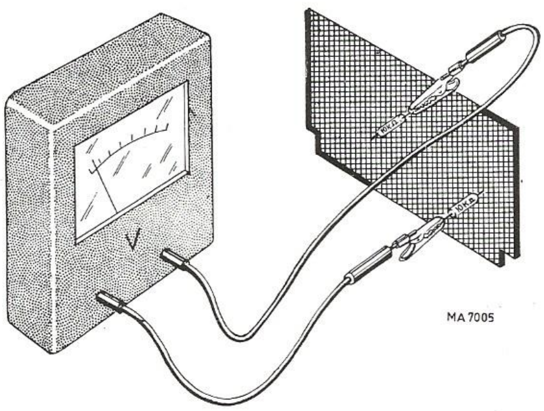



*Fig. XI-3. A 10 kΩ resistor fixed on each test pin to avoid parasitic oscillations*

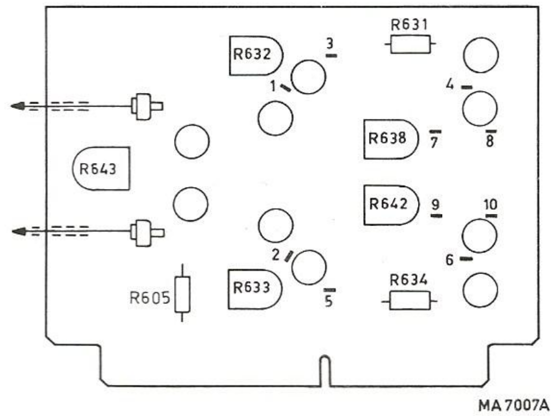



*Fig. XI-4. Test points vertical output amplifier*

– The voltages across R639 and R641 (points 7-8 and 9-10 respectively in Fig. XI-4) must be 3,1 V + or –200 mV. If necessary, these voltages can be adjusted with R638 and R642 respectively (the voltmeter may here be used without series resistors).
– Connect the voltmeter (as indicated in Fig. XI-3) between the collector of TS606, and the junction of TS608 and TS609 collectors (points 3 and 4 in Fig. XI-4).
Adjust potentiometer R632 LEV. until this voltage is 0 V + or –200 mV (if necessary, change R631).
– Connect the voltmeter (as indicated in Fig. XI-3) between the collector of TS607, and the junction of TS611 and TS612 collectors (points 5 and 6 in Fig. XI-4).
Adjust potentiometer R633 LEV. until this voltage is 0 V + or –200 mV (if necessary, change R634).
– With both Y channel switches in the OFF position the trace must be approximately in the screen centre.
If necessary adjust R643.

### 6. H.F. Square-wave response and rise-time

Optimum h.f. square-wave response and rise-time depend on correct adjustment of the pre-amplifiers and the intermediate amplifier.
In this procedure check that the displayed leading edge top is free from ringing, overshoot and undershoot.
Flat-top error should not exceed 2 % for the A or B channel mode, or 5 % for the A–B or –B mode.
Rise-time must be less than 7 ns.
The alignment of the input attenuators of the pre-amplifiers as well as the main time-base sweep time calibration must be in order (refer to chapters D.1.e. and F.3).
Adjust the main time-base TIME/div. control and the trigger LEVEL control to obtain a suitable display of a square-wave leading edge top. Various settings of the main time-base TIME/div. control may be necessary for optimum viewing results.
Vertical deflection during this procedure is four divisions.

Required instruments:
- Square-wave generator, 100 kHz, rise-time less than 3 ns. Tektronix type 106 square-wave generator recommended.
- Use a 50 ohm in-line cable end termination plugged onto the oscilloscope input.

General settings:
- Main time-base trigger selectors: TRIGG., HF, +.
- X DEFL. switch to MAIN TB.
- GAIN switch to X1.
- Both AC/0/DC switches to AC.

*Channel A*

- Trigger selector switch to $Y_A$.

#### a. H.F. square-wave response

- A/OFF/A–B switch to A.
- B/OFF/–B switch to OFF.
- Apply the (100 kHz, Tr < 3 ns) square-wave signal of 80 mV to the $Y_A$ input.
- $Y_A$ AMPL. switch to 20 mV/div. (cont. control to CAL).
- Centre the display with the $Y_A$ and X POSITION knobs.
- If necessary adjust the following controls or selecting components; note that it is important to adjust the controls in their stated sequence. See Fig. XI-5.

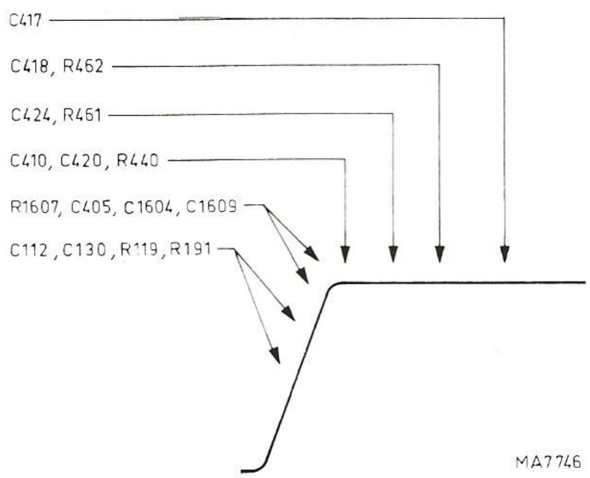



*Fig. XI-5. HF Square-wave response channel A*

- $Y_A$ AMPL switch to 2 mV/div.
- $Y_A$ input voltage 8 mV.
  If necessary adjust R143.
- A/OFF/A–B switch to A–B
- $Y_A$ AMPL switch to 20 mV/div.
- $Y_A$ input voltage 80 mV.
  If necessary adjust C1601 or R1602 or change C1600 or C1608.

**b. Rise-time**

- Check the rise-time, see Fig. XI-6 in position 2–, 5– and 10 mV/div. of the $Y_A$ AMPL switch (reduce the input voltage in these positions to obtain a four-division vertical deflection).

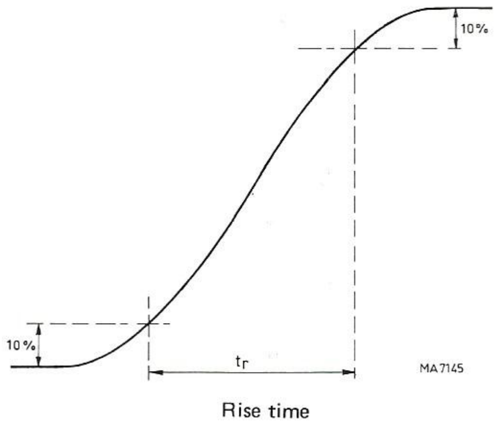



*Fig. XI-6. Definition Rise-Time*

- If necessary change in the 2 mV/div. position: C123 or R175.

*Channel B*

- Trigger selector to $Y_B$.

**a. H.F. square wave response**

- B/OFF/–B switch to B.
- A/OFF/A–B switch to OFF.
- Apply the (100 kHz, Tr < 3 ns) square-wave signal of 80 mV to the $Y_B$ input.
- $Y_B$ AMPL switch to 20 mV/div. (cont. control to CAL).
- Centre the display with the $Y_B$ and X POSITION knobs.
- If necessary adjust following controls or selecting components.
  See Fig. XI-7.

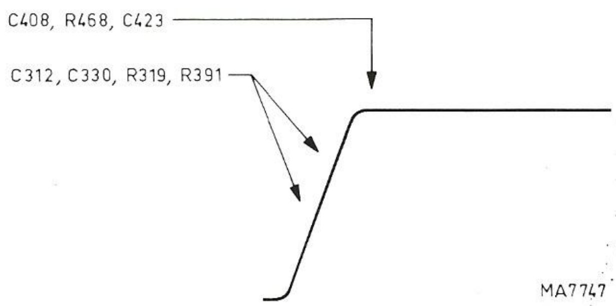



*Fig. XI-7. HF Square-wave response channel B*

- $Y_B$ AMPL switch to 2 mV/div.
- $Y_B$ input voltage 8 mV.
  If necessary adjust R343.
- B/OFF/−B switch to −B.
- $Y_B$ AMPL switch to 20 mV/div.
- $Y_B$ input voltage 80 mV.
  If necessary change C404.

**b. Rise-time**

- Check the rise-time see fig. XI-6 in position 2−, 5−, and 10 mV/div. of the $Y_B$ AMPL switch (reduce the input voltage in these positions to obtain a four division vertical deflection).
- If necessary change in the 2 mV/div. position: C323 or R375.

**7. Upper bandwidth limit**

Required instruments:

- Constant amplitude sine-wave signal generator, frequency to above 50 MHz.
  Tektronix type 191 constant-amplitude signal generator recommended.
- Use a 50 ohm in-line cable end termination plugged onto the oscilloscope input.
  The height of the displayed 50 MHz waveform must be at least 0,75 times the height at 100 kHz, for each input (in the 2 mV/div. position of the attenuators it may be 0,7 times).

  When the bandwidth is not sufficient the h.f. square-wave response must be readjusted.
  When the GAIN switch is in position x10, the bandwidth is limited to 5 MHz.

**8. Common mode rejection**

With the A/OFF/A−B switch to A−B and the same input signal on both Y inputs (B/OFF/−B switch to B) there must be no vertical deflection.

Required instrument:
A sine-wave generator 100 Hz - 20 MHz.

- A/OFF/A−B switch in position A−B.
- The AMP. continuous controls to CAL.
- Same sine-wave signal on both Y inputs.
- Check the rejection in accordance with the following table:

| *Setting AMPL. switches* | *GAIN switch setting* | *$V_{p-p}$ of input* | *Freq. of input* | *Max. trace height (div.)* | *Rejection factor* |
|---|---|---|---|---|---|
| 20 mV/div. | x1 | 800 mV | 100 Hz | 0,1 | 400 |
| 20 mV/div. | x1 | 800 mV | 2 kHz | 0,1 | 400 |
| 20 mV/div. | x1 | 800 mV | 1 MHz | 0,2 | 200 |
| 20 mV/div. | x1 | 800 mV | 5 MHz | 0,8 | 50 |
| 20 mV/div. | x1 | 800 mV | 20 MHz | 2,0 *) | 20 |
| 20 mV/div. | x10 | 800 mV | 100 Hz | 0,1 | 400 |
| 20 mV/div. | x10 | 800 mV | 2 kHz | 1,0 | 400 |
| 20 mV/div. | x10 | 800 mV | 1 MHz | 4,0 | 100 |

*) Correction of this figure is possible with C128/U15; after adjustment of this capacitor, checking of the h.f. response of the vertical amplifiers is necessary.

## E. TRIGGERING

The trigger circuit consists of the trigger pick-off stage (unit U25), and the trigger amplifiers on the main time-base (unit U12) and the delayed time-base (unit U11).

The following checks and adjustments are discussed:

1. D.C. levels main time-base R901/U12, R914/U12, R505/U25, R525/U25, R933/U12
2. D.C. levels delayed time-base R701/U11, R714/U11, R733/U11
3. Slope main time-base R957/U12
4. Slope delayed time-base R772/U11

Required instruments:
A d.c. voltmeter
A sine-wave generator (2 kHz)

### 1. D.C. levels main time-base

The three trigger inputs are adjusted to the same level, with the voltage across R941 as a reference.
- AC/0/DC switches of both Y inputs to 0.
- LEVEL potentiometer of main time-base to mid-position (knob depressed = x1 position).

*Channel A:*

- $Y_A/Y_B$/EXT. trigger switch to $Y_A$.
- Potentiometer R505/U25 to mid-position.
- Check that the voltage across R941/U12 (MP in Fig. XI-8) does not exceed 100 mV (negative with respect to earth), if the trigger switch LF/HF/DC is in the HF position.
  If this voltage exceeds 100 mV, replace TS908 (or TS909).
- LF/HF/DC trigger switch to DC.
- Adjust R901/U12 (CH.A) in order to obtain the same voltage across R491/U12, as in position HF or LF of the trigger switch (if necessary change R906/U12).
- GAIN switch to x10.
- Adjust R505/U25 in order to obtain the same voltage across R491/U12.
- Repeat the adjustments of R901/U12 (R906) and R505/U25 until optimum results are obtained.

*Channel B:*

- $Y_A/Y_B$ EXT. trigger switch to $Y_B$.
- Potentiometer R525/U25 to mid-position.
- GAIN switch to x1.
- LF/HF/DC trigger switch to DC.
- Adjust R914/U12 (CH.B) in order to obtain the same voltage across R941/U12 as measured at channel A (if necessary change R919/U12).
- GAIN switch to x10.
- Adjust R525/U25 in order to obtain the same voltage across R941.
- Repeat the adjustments of R914 (R919) and R525 until optimum results are obtained.

*EXT.*

- $Y_A/Y_B$/EXT. switch to EXT.
- LF/HF/DC switch to DC.
- Adjust R933/U12 in order to obtain the same voltage across R941/U12.

### 2. DC levels delayed time-base

The three trigger inputs are adjusted to the same level with the voltage across R741/U11 as a reference. First check that the main time-base trigger circuits are properly adjusted; see point **1**.
- AC/0/DC switches of both Y inputs to 0.
- LEVEL potentiometer of the delayed time-base to mid-position (knob depressed = x1 position).

*Channel A:*

- Set the $Y_A/Y_B$/EXT. trigger switch of the delayed time-base to $Y_A$.
- Check that the voltage across R741/U11 (M P in Fig. XI-8) does not exceed 100 mV (negative with respect to earth), if the trigger switch LF/HF/DC is in the HF position.
  If this voltage exceeds 100 mV, replace TS708 (or TS709).

– LF/HF/DC trigger switch to DC.
– Adjust R701/U11 (CH.A) in order to obtain the same voltage across R741, as in position HF (if necessary, change R703).

*Channel B:*

– $Y_A/Y_B$/EXT. trigger switch to $Y_B$.
– LF/HF/DC trigger switch to DC.
– Adjust R714/U11 (CH.B) in order to obtain the same voltage across R741/U11 (if necessary, change R717).

*EXT.*

– $Y_A/Y_B$/EXT. switch to EXT.
– LF/HF/DC switch to DC.
– Adjust R733/U11 in order to obtain the same voltage across R741/U11.

**3. Slope main time-base**

– A/OFF/A–B switch to A.
– AC/0/DC switch of $Y_A$ to AC.
– B/OFF/–B switch to OFF.
– Main time-base trigger selector switches to TRIGG., $Y_A$ and LF.
– Apply a 2 kHz sine-wave signal to the $Y_A$ input.
– Adjust the amplitude of the input signal in order to obtain a four division display height.
– Centre the display using the $Y_A$ POSITION potentiometer.
– Main time-base switch to .1 ms/div.
– Set the LEVEL potentiometer of the main time-base for a stable display.
– Set the X POSITION potentiometer so that the beginning of the sine-wave pattern is well visible.
– Adjust the LEVEL potentiometer in conjunction with potentiometer R957/U12 in order to obtain a condition in which the starting point of the sine-wave does not jump when the slope switch +/– is switched between its + and – positions.
– Reduce the input signal amplitude until a display height of 0,5 div. is obtained.
– Adjust the LEVEL potentiometer for a stable display.
– Check that the display remains triggered when the slope switch +/– is switched between its +/– is switched between its + and – positions.
– Make any necessary readjustment to potentiometer R957/U12.
– Eventually can, with still smaller input signals be checked whether the display is stable in both + or – slope switch conditions.
If the display is stable in one polarity condition and running in the other one, potentiometer R957/U12 can be readjusted in order to obtain a stable display for both polarities.
If necessary, adjust the LEVEL potentiometer.

**4. Slope delayed time-base**

– A/OFF/A–B switch to A.
– AC/0/DC switch of $Y_A$ to AC.
– B/OFF/–B switch to OFF.
– X DEFL. switch to DEL' D TB.
– Main time-base switch to .1 ms/div.
– Main time-base trigger switches to AUTO and EXT. (the main time-base is now free-running).
– Delayed time-base to .1 ms/div.
– Delayed time-base trigger switches to $Y_A$ and LF.
– AFTER DELAY TIME switch to TRIGG.
– DELAY-TIME multiplier to zero.
– Apply a 2 kHz sine-wave signal to the $Y_A$ input.
– Set the $Y_A$ AMPL. switch and the LEVEL potentiometer of the delayed time-base in order to obtain a stable display of four divisions height.
– Adjust the LEVEL potentiometer of the delayed time-base in conjunction with potentiometer R772/U11 in order to obtain a condition in which the starting point of the sine-wave does not jump when the delayed time-base slope switch is switched between its + and – positions.
– Reduce the input signal amplitude until a display height of 0,5 div. is obtained.
– Set the LEVEL potentiometer of the delayed time-base for a stable display.

- Check that the display remains triggered when the trigger slope switch +/– is switched between its + and – positions.
- Make any necessary readjustment to potentiometer R772/U11.
- Eventually can, with still smaller input signals be checked whether the display is stable in both + or – slope conditions.
  If the display is stable in one polarity condition and not visible in the other one, potentiometer R772/U11 can be readjusted in order to obtain a stable display for both polarities.
  If necessary, adjust the delayed time-base LEVEL potentiometer.

## F. MAIN TIME-BASE

Because the accuracy of the time-base sweep is dependent upon the adjustment of the horizontal output amplifier reference has also to be made to chapter **H**.
For the main time-base following adjustments are important:

1. Stability R1036/U12 (STAB.)
2. Gain (horizontal amplifier)
3. Sweep times R1049/U12 (NORM.), R1052/U12 (LOW) C937/U12
4. Linearity (horizontal amplifier)
5. Delayed time-base

Required instrument:
Marker generator

### 1. Stability

- Both AC/0/DC switches to 0.
- MAIN TIME-BASE switch to 1 ms/div.
- Potentiometer LEVEL fully anti-clockwise.
- AUTO/TRIGG./SINGLE switch to TRIGG.
- Potentiometers R1036/U12 (STAB.) fully clockwise.
- Adjust potentiometer R1036 20° further than the point where the time-base line ceases to be displayed.

### 2. Gain

Refer to chapter H.2.

### 3. Sweep times

When the gain of the horizontal amplifier has been adjusted (see chapter H.2.) the sweep times can be adjusted.
- Apply a 10 ms marker signal to the $Y_A$ input.
- MAIN TIME-BASE switch to 10 ms/div. (cont. control to CAL.).
- Adjust R1052/U12 (LOW) so, that the centre eight pulses are presented over exactly eight divisions.
- Marker generator to 1 ms.
- MAIN TIME-BASE switch to 1 ms/div.
- Adjust R1049/U12 (NORM.) so, that the centre eight pulses are presented over exactly eight divisions.
- Marker generator to 0.1 μs.
- MAIN TIME-BASE switch to .1 μs/div.
- Adjust C937/U12 to obtain a display of one pulse per division.

### 4. Linearity

Refer to chapter H.3.

### 5. Delayed time-base

If the main time-base has been readjusted also the delayed time-base must be checked and, if necessary, readjusted.

## G. DELAYED TIME-BASE

Because the accuracy of the delayed time-base depends upon the adjustment of the horizontal output amplifier, reference has also to be made to chapter H.

Following checks and adjustments are important:

1. Stability R807/U11 (STAB.)
2. Gain (horizontal amplifier)
3. Sweep times R819/U11 (NORM.), R824/U11 (LOW), C734/U11
4. Linearity (horizontal amplifier)
5. Delay-time multiplier R1090/U12 (START), R1094/U12 (STOP)
6. Main time-base

Required instrument:
Marker generator

### 1. Stability

- Both AC/0/DC switches to 0.
- X DEFL. switch to DEL'D TB.
- MAIN TIME-BASE switch to .2 ms/div.
- DELAY TIME multiplier to 0.
- AFTER DELAY TIME switch to TRIGG.
- DELAYED TIME-BASE switch to .1 ms/div.
- LEVEL potentiometer of the delayed time-base fully clockwise.
- Potentiometer R807/U11 (STAB) fully clockwise.
- Adjust potentiometer R807 $20^{o}$ further than the point at which the time-base line ceases to be displayed.
- When the AFTER DELAY TIME switch set to STARTS a time-base line should appear.

### 2. Gain

Refer to chapter H.2.

### 3. Sweep times

When the gain of the horizontal amplifier and the sweep times of the main time-base are in order the sweep times can be adjusted.

- Apply a 10 ms marker signal to the $Y_A$ input.
- X DEFL. switch to DEL'D TB.
- DELAYED TIME-BASE switch to 10 ms/div. (cont. control to CAL).
- MAIN TIME-BASE to 20 ms/div. (cont. control to CAL).
- AFTER DELAY TIME switch to STARTS.
- DELAY TIME multiplier to 0.
- Set the LEVEL potentiometer of the main time-base in order to obtain a stable display.
- Adjust the display by means of potentiometer R824/U11 (LOW) so that the centre eight pulses are presented over exactly eight divisions.
- Marker generator to 1 ms.
- DELAYED TIME-BASE switch to 1 ms/div.
- MAIN TIME-BASE switch to 2 ms/div.
- Adjust the display by means of potentiometer R819/U11 (NORM.) so that the centre eight pulses are presented over exactly eight divisions.
- Marker generator to 0,1 μs.
- DELAYED TIME-BASE switch to .1 μs/div.
- MAIN TIME-BASE switch to .2 μs/div.
- Adjust the display by means of C734/U11 so that the centre eight pulses are presented over exactly eight divisions.

### 4. Linearity

Refer to chapter H.3.

### 5. Delay-time multiplier

- Apply a 1 kHz sine-wave signal to the $Y_A$ input.
- X DEFL. switch to MAIN TB.

- MAIN TIME-BASE to 1 ms/div. (cont. control to CAL.).
- DELAYED TIME-BASE to 2 μs/div. (cont. control to CAL.).
- AFTER DELAY TIME switch to STARTS.
- Centre the display with the $Y_A$ POSITION potentiometer.
- Set the LEVEL potentiometer of the main time-base so that the sine-wave display starts on the horizontal centre line.
- DELAY-TIME multiplier to 1.00.
- Adjust potentiometer R1090/U12 (START) so that the beginning of the intensified portion of the display starts at the beginning of the second period.
- DELAY-TIME multiplier to 9.00.
- Adjust potentiometer R1094/U12 (STOP) so that the beginning of the intensified portion starts at the beginning of the tenth period.
- Repeat the above procedure in order to obtain optimum results.

**6. If necessary, also check the main time-base**

## H. HORIZONTAL AMPLIFIER

This amplifier consists of the output amplifier U23, and an amplifier stage on the time-base unit (U12). Only for the EXTERN via $Y_B$ mode an additional amplifier is used, located on unit U26b.

The horizontal amplifier is provided with the following checking and adjusting possibilities:

1. D.C. level R1109/U12 (DC)
2. Gain R1122/U12 (x1), R1123/U12 (x5)
3. Linearity C1176, C1178/U23
4. EXT. via $Y_B$ amplifier on unit U26b (R1166, R1159)
5. Bandwidth

The horizontal amplifier must be checked or adjusted if the time-base has been readjusted or the cathode-ray tube has been replaced.

Required instruments:
A d.c. voltmeter, free from earth
A marker generator (1 ms ... 10 ns)

**1. D.C. level**

- X DEFL. switch to EXTERN via $Y_B$.
- A/OFF/A–B switch to OFF.
- B/OFF/–B switch to B.
- Using a d.c. voltmeter (free from earth), adjust the channel $Y_B$ POSITION potentiometer, until the potential between the horizontal-deflection plates (side connections red and yellow of the c.r.t.) is zero (max. + or –0,5 V).
- Taking care not to move the setting of the POSITION potentiometer, adjust potentiometer R1109/U12 (D.C.) until the horizontal deflection plates are within + or –1 V with respect to chassis (if necessary, check the d.c. level of the amplifier located on U26b; see point 4).
- Check that the trace is about centralized on the screen.

**2. Gain**

Gain adjustment can be effected in different ways.

a. Assuming the time-base circuits being in order, the gain can be adjusted using a marker generator as a reference.
   - X DEFL. switch to MAIN TB.
   - Apply a 1 ms marker signal to the Y input.
   - MAIN TIME-BASE switch to 1 ms/div.
   - X MAGN. switch depressed.
   - Adjust R1122/U12 (x1) in order to obtain a display of one pulse per division.
   - MAIN TIME-BASE switch to 5 ms/div.

- X MAGN. switch to x5 (knob pulled out).
- Adjust R1123/U12 (x5) in order to obtain a display of one pulse per division (if necessary change R1124).

b. Assuming both time-base and the horizontal amplifier have been replaced, the horizontal amplifier could be adjusted with the aid of a calibrated sine-wave voltage applied via the EXT via $Y_B$ socket to the horizontal amplifier on unit U26b.

If necessary, readjust the gain adjustment (R1166) of the amplifier on unit U26b (See point **4**).

**3. Linearity**

- Apply a 10 ns marker signal to the $Y_A$ input,
- MAIN TIME-BASE switch to .05 µs/div. (cont. control to CAL).
- X MAGN switch to x5 (knob pulled out).
- X POSITION potentiometer to mid-position.
- Adjust trimmers C1176 and C1178 so, that the eight central periods are presented over an exact width of eight divisions, and that the periods are as equal as possible.
  Use the X POSITION potentiometer over its full range to examine the whole display for any possible deviation (this check does not apply for the first five and the last five periods of the whole trace).

**4. EXT. via $Y_B$**

a. Balance

- A/OFF/A–B switch to OFF.
- B/OFF/–B switch to B.
- X DEFL. switch to MAIN TB.
- Adjust the trace to the centre of the screen with the $Y_B$ POSITION knob.
- X DEFL. switch to EXTERN via $Y_B$.
  The dot must now be in the centre of the screen.
  If necessary adjust R1159/U26b.

**b. Gain**

Refer to previous point **2.b.**

**5. Bandwidth**

- X DEFL. switch to EXT. via $Y_B$.
- Apply a constant-amplitude sine-wave signal to the $Y_B$ input.
- Check that the horizontal deflection at 5 MHz is not less than 0,7x the deflection at 100 kHz.

## I. CALIBRATION UNIT

Check that the square-wave signal present at the CAL. socket has an amplitude of 600 mV ±0,7 % (if necessary adjust with R1263/U9).
Check that the frequency of the square-wave is 2 kHz ±0,7 % (if necessary, adjust with R1256/U9).

## J. PM 3250X

**1. Introduction**

The PM 3250X may be calibrated in the same way as stated in the checking and adjusting section of the basic PM 3250, provided that the PULL FOR TV FRAME and PULL FOR TV LINE switches are both depressed (i.e. sync. separator outputs not coupled). Additional calibration procedures required for the PM 3250X are detailed in the following paragraphs.

**2. Sync. separator**

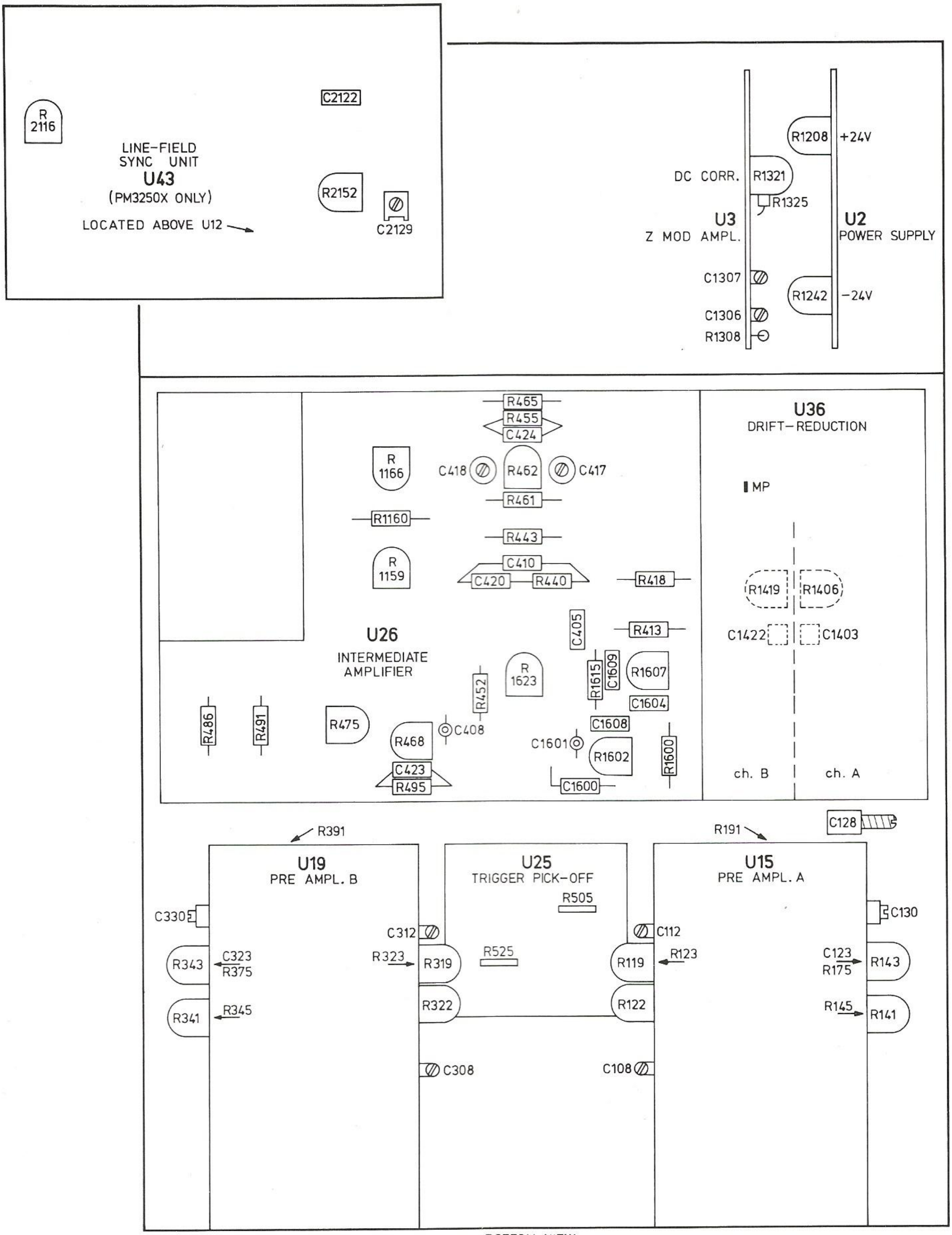
- R2116/U43, which serves for adjusting the symmetry of the source and drain signals of TS2103, must be in its mid position.

**3. External horizontal input**

- Set the X DEFL. switch to EXTERN.
- Set the horizontal attenuator (R20) located at the right-hand side of the cabinet, in the calibrated position (fully clockwise).
- Apply a 2 kHz sine-wave signal of 6 $V_{p-p}$ to the TRIGG./EXT. X input.
- Adjust R2152//U43 in order to obtain a 6 div. deflection (deflection factor 1 V/div.)
- Now apply a 10 kHz square-wave signal 6 $V_{p-p}$ to the TRIGG./EXT. X input.
- Connect a saw-tooth signal, which is triggered by the 10 kHz square-wave, to the $Y_A$ input.
- Adjust C2129/U43 (eventually C2122/U43) for optimum square-wave response.

---

Reference item no. to page no. chapter Checking and Adjusting.


R 2116
C2122
LINE-FIELD SYNC UNIT
U43
(PM3250X ONLY)
LOCATED ABOVE U12
R2152
C2129
R1208
+24V
DC CORR.
R1321
R1325
U3
Z MOD AMPL.
U2
POWER SUPPLY
C1307
R1242
-24V
C1306
R1308
R465
R455
C424
R 1166
C418
R462
C417
R461
R1160
R443
C410
R 1159
C420
R440
R418
U36
DRIFT-REDUCTION
MP
R1419
R1406
C1422
C1403
C405
R413
U26
INTERMEDIATE AMPLIFIER
R 1623
R452
R1615
C1609
R1607
C1604
R486
R491
R475
C408
R468
C1608
C1601
R1602
R1600
C423
R495
C1600
ch. B
ch. A
R391
R191
C128
U19
PRE AMPL. B
U25
TRIGGER PICK-OFF
U15
PRE AMPL. A
R505
C330
C312
C112
C130
R343
C323
R375
R323
R319
R525
R119
R123
C123
R175
R143
R322
R122
R341
R345
R145
R141
C308
C108
BOTTOM VIEW

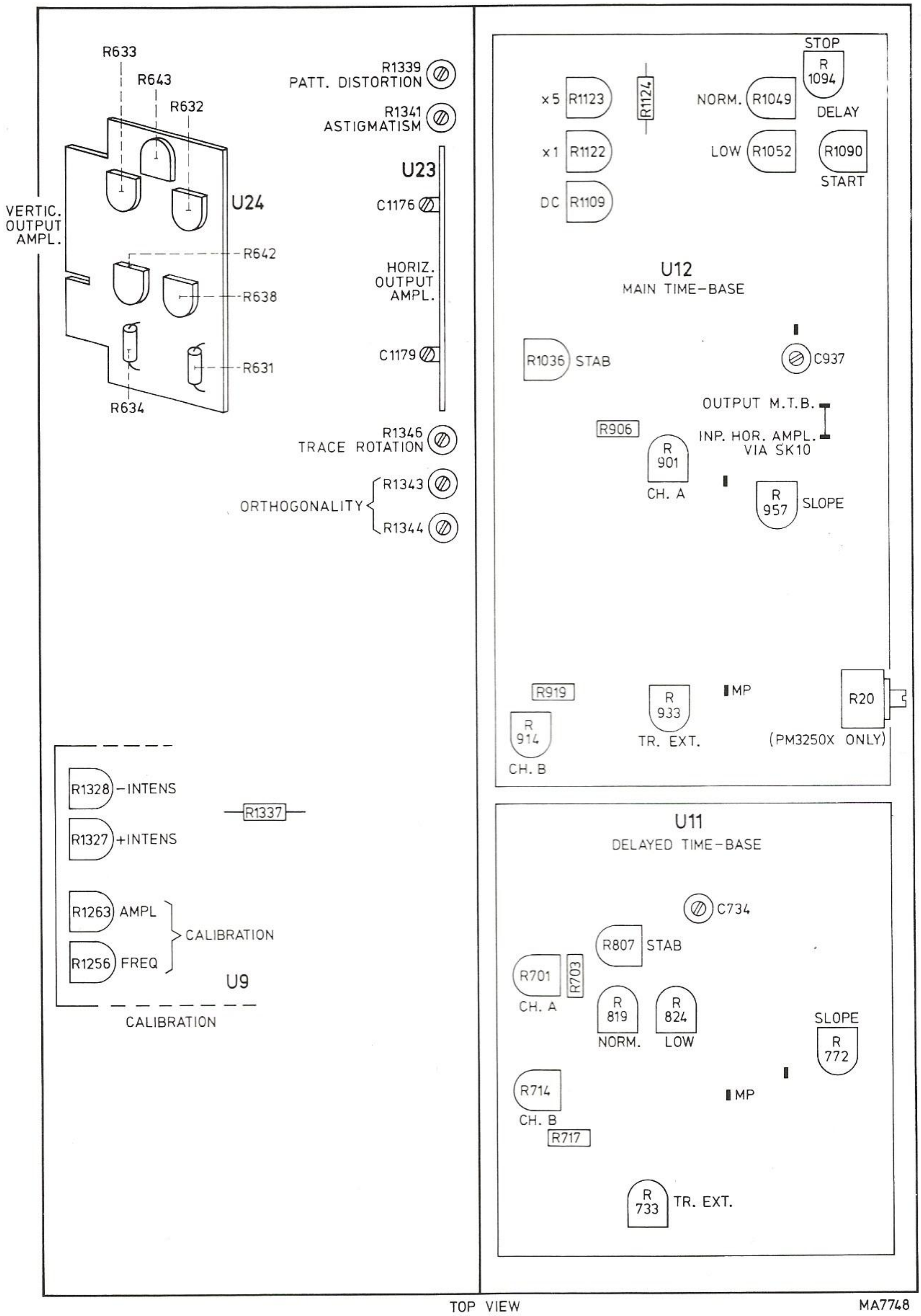



*Fig. XI-8. Location various adjustment points*

# XII. Information for assistance in fault finding

## A. VOLTAGE LEVELS

The d.c. levels on the most important points of the circuits have been indicated on the circuit diagrams.
These values may slightly differ per instrument.
The measurements have been carried out under the following conditions:

- Switch "AUTO/TRIGG/SINGLE" in position "AUTO".
- Switch "X DEFL" in position "MAIN TB".
- Switches "AC-0-DC" in position "0".
- Switch "GAIN" in position "x1".
- Potentiometers "Y POSITION" in the centre position.
- Switch "TIME/div" of the main time-base in position "1 ms/div.".
- For measurements in channel A; switch "B/OFF/–B" in position "OFF" and switch "A/OFF/A–B" in position "A".
- For measurements in channel B: switch "B/OFF/–B" in position "B" and switch "A/OFF/A–B" in position "OFF".

## B. WAVEFORMS

In some circuit diagrams voltage waveforms are shown. The various switch positions are given in these diagrams.

## C. REPAIR HINTS

**1. Fault: there is only trace A visible**

- Check that the d.c. level on the output of the pre-amplifier A (thus on the cursor of R14) is 0 V.
  If not, change the connections between the pre-amplifiers and the drift reduction circuits. (Thus connect R127 to R1439, R327 to R1417, R134 to R1423, R334 to R1401).
- If there is now only trace B visible, then the drift reduction circuit of channel A is defective.
- If there is now only trace A visible, then the pre-amplifier of channel A is defective.

**2. Fault: there is only trace B visible**

- Check the pre-amplifier and the drift reduction circuit of channel B according to point C.1.

**3. Fault: the pre-amplifier A is defective**

- Remove the connection between R127 and R1417.
- Check that the d.c. levels on the different points of pre-amplifier A have the values indicated on the circuit diagram.

**4. Fault: the pre-amplifier B is defective**

- Remove the connection between R327 and R1439.
- Check that the d.c. levels on the different points of pre-amplifier B have the values indicated on the circuit diagram.

**5. Fault: the drift reduction circuit is defective**

- Check the square-wave voltage of the multivibrator TS1409 - TS1411 (on collector of TS1409: +5/–10 V 1700 Hz)
- Check whether the square-wave signal is present on the input and output of the operational amplifiers IC1401 and IC1402).

**6. Fault: no traces visible**

- Remove final transistors TS422 and TS424 of the intermediate amplifier.
  A horizontal line should now appear on the centre of the screen. If not, check the delay line and the vertical output amplifier.

## D. MODIFICATIONS

During manufacturing following circuit-modifications have been carried out:

1. To avoid the possibility of oscillation if the power supply is short-circuited, R1275 (750 ohm CR16 5 %) in series with C1240 (10 nf 40 V) have been connected between the collector of TS1217 and earth.
2. C878 on the main time-base switch has been modified to 120 pF (for some units the hold-off time was too short resulting in an oscillation phenomenon on the trace).
3. Z-diode GR1310/U4 has been modified to type BZX61/C47 for two reasons:
   - Recent CRT's need somewhat higher grid cut-off voltage.
   - To withstand the discharge current of C1312 when B1301 is ignited (when switching-on).
4. To avoid overheating of TS728 and TS941 In the time-base units, R829 and R1064 have been changed to 8200 ohm (0,5 W 5 %).

Above modifications have been worked already in the circuit diagrams of this manual.
We advise to incorporate these modifications on apparatuses as they come to hand.

## E. NOTES

In case of a defect it is always possible to apply to the world wide Philips Service Organisation.
When the instrument is to be sent to a Philips Service Workshop for repair, the following points should be observed:

- Attach a label with your name and address to the instrument.
- Give a complete description of the faults found.
- Use the original packing or, if this is no longer available, carefully pack the instrument in a wooden crate or box.
- Send the instrument to the address obtained after consultation with the local Philips Organisation.

# XIII. List of parts

## MECHANICAL PARTS

| *Item* | *Code number* | *Description* |
|---|---|---|
| **Front side photograph Fig. XIII-1** | | |
| 1 | 5322 413 30164 | Knob of SK13 |
| 2 | 5322 413 30346 | Knob Ø 14,5 - Ø 6 flat-face shaft (R6, R7) |
| 3 | 5322 413 30083 | Knob Ø 14,5 - Ø 4 (R8, R16, R17) |
| 4 | 5322 413 90026 | Bourns knob, compl. (R4) |
| 5 | 5322 413 40112 | Knob Ø 23 - Ø 6 with white line (SK7, SK11, SK26, SK27) |
| | 5322 413 30085 | Knob Ø 14,5 - Ø 4 with red line (R2, R5, R14, R15) |
| | 5322 413 70039 | Cap with red line, for Ø 14,5 knobs |
| 6 | 5322 413 30082 | Knob Ø 14,5 - Ø 6 (R1/SK5, R3/SK9, R9/SK19) |
| 2, 3, 6 | 5322 413 70038 | Cap with black line, for Ø 14,5 knobs |
| 7 | 5322 404 60058 | Switch knob with mechanism (SK1...4, SK10, SK20...25) |
| | 5322 404 50592 | Clamping bracket for switch lever (SK1...4, SK10, SK20...25) |
| | 5322 502 11235 | Screw M 2,5 for clamping bracket |
| 8 | 5322 404 60057 | Switch knob with mechanism (SK15...18) |
| 9 | 5322 267 10004 | BNC socket (BU1...4, BU8) |
| 10 | 5322 265 30096 | Outlet 'Probe Power' (BU5, BU7) |
| 11 | 5322 268 20021 | 4 Ø socket ⏚ |
| 12 | 5322 462 10103 | Tilting bracket |
| | 5322 462 44067 | Tilting bracket hinge block |
| 13 | 5322 498 54003 | Carrying handle |
| 14 | 5322 381 14042 | Light coupler 'Power On' (LA5) |
| 15 | 5322 455 80054 | Text plate PM 3250 |
| | 5322 455 84004 | Text plate PM 3250X |
| 16 | 5322 381 10152 | Lens 'Magn. On' (LA4) |
| 17 | 5322 459 40233 | Bezel |
| 18 | 5322 480 30078 | Contrast filter, grey |
| | 5322 480 34037 | Contrast filter, green |
| | 5322 480 34036 | Contrast filter, yellowish-green PM 3250G |
| 19 | 5322 417 24006 | Quick-Fastener compl. |
| **Rear side photograph Fig. XIII-2** | | |
| 20 | 5322 462 40253 | Rubber strip |
| 21 | 5322 255 40091 | Insulation cover |
| | 5322 255 40072 | Mica plate and bushing (56 101) |
| | 5322 255 40085 | Transistor socket |
| 22 | 5322 256 40026 | Fuse cartridge |
| 23 | 5322 462 40252 | Rubber foot |
| 24 | 5322 462 70737 | Cover of voltage adaptor |
| 25 | 5322 267 10004 | BNC socket (BU9...BU12) |
| | 5322 462 54021 | Shielding cap (rear side BU9, 11, 12) |
| | 5322 506 14001 | Special nut for shielding cap 3/8'' (32 NEF) |
| | 5322 290 34022 | Soldering lug Ø 10 (BU10, 12) |
| **Top side photograph Fig. XIII-3** | | |
| 26 | 5322 320 40032 | Coaxial delay line L501 (length approx. 45 cm) |
| 27 | 5322 320 10064 | Coaxial cable (50 cm) with plug (50 Ω) |

| Item | Code number | Description |
|---|---|---|
| 28 | 5322 492 64079 | V-spring, slide switch drive |
| 29 | 5322 528 20165 | Flexible shaft coupling |
| 30 | 5322 255 10007 | Lamp holder (LA4, LA5) |
| 31 | 5322 255 20022 | Lamp holder (LA1, LA2) |
| | 5322 462 44023 | Insulation cover of lamp holders (LA1, LA2) |
| 32 | 5322 320 24001 | High tension cable complete with connector |
| 33 | 5322 219 80158 | Delay line (L603) complete (char. imp. 50 Ω; delay time 65 ns) |
| 34 | 5322 462 30117 | Guide part for print panels |
| 35 | 5322 255 40054 | Transistor cooling radiator (TO-5) |
| 36 | 5322 255 40089 | Transistor socket (TO-18) with four contacts* |
| 37 | 5322 255 40015 | Transistor socket (TO-5) |
| 37a | 5322 255 44014 | Transistor socket 8-pole (TO-71) |
| 38 | 5322 255 70159 | C.r.t. socket |
| 39 | 5322 267 60023 | P.c. connector with double row soldering lugs |
| 40 | 5322 267 50122 | P.c. connector with one row side soldering lugs |
| 41 | 5322 267 60034 | P.c. connector with double row soldering lugs |

**Service tools**

| | | |
|---|---|---|
| – | 5322 395 50104 | Trimming rod for input attenuator capacitors |
| | 5322 263 70035 | Extension p.c. board |

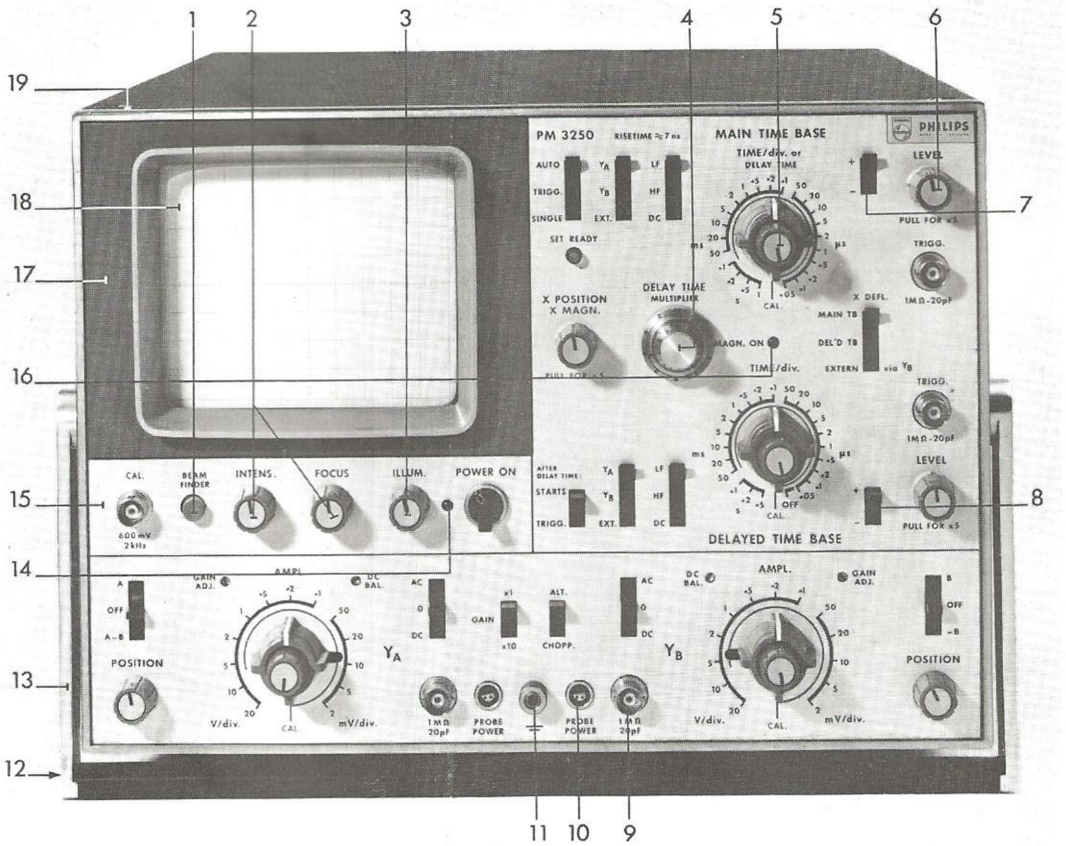



*Fig. XIII-1. Front side view*

* For replacement of a socket with three contacts, one contact of the replacement socket must be removed.

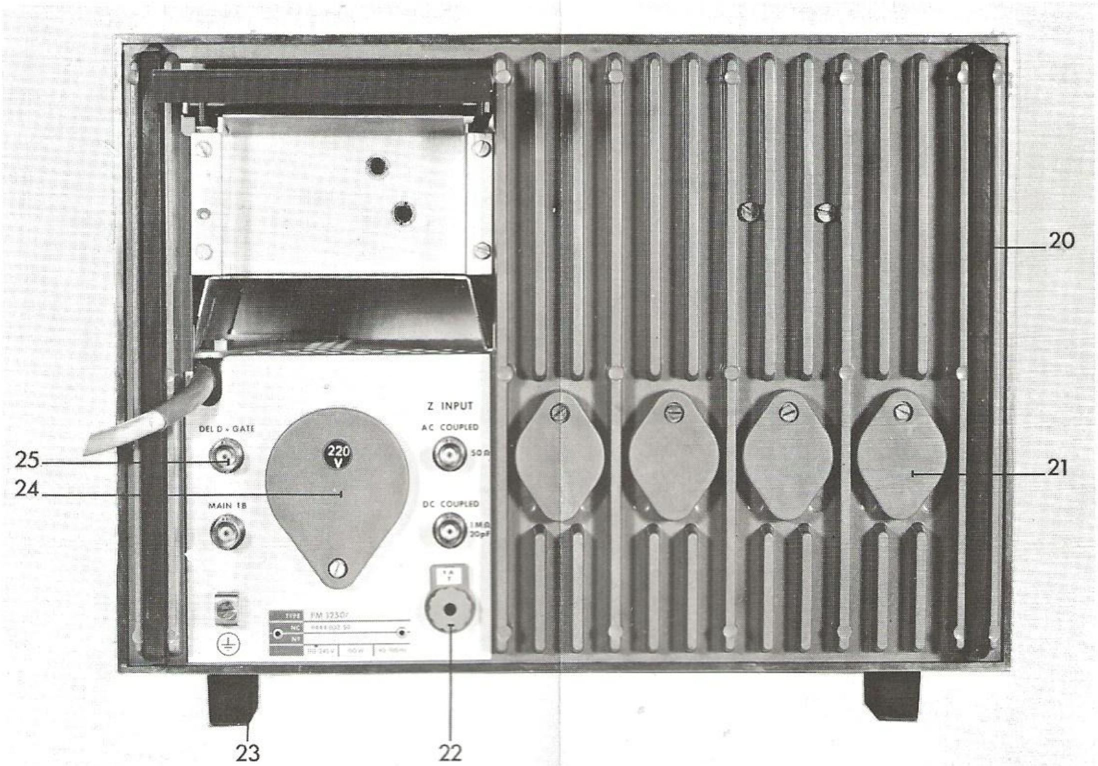



*Fig. XIII-2. Rear side view*

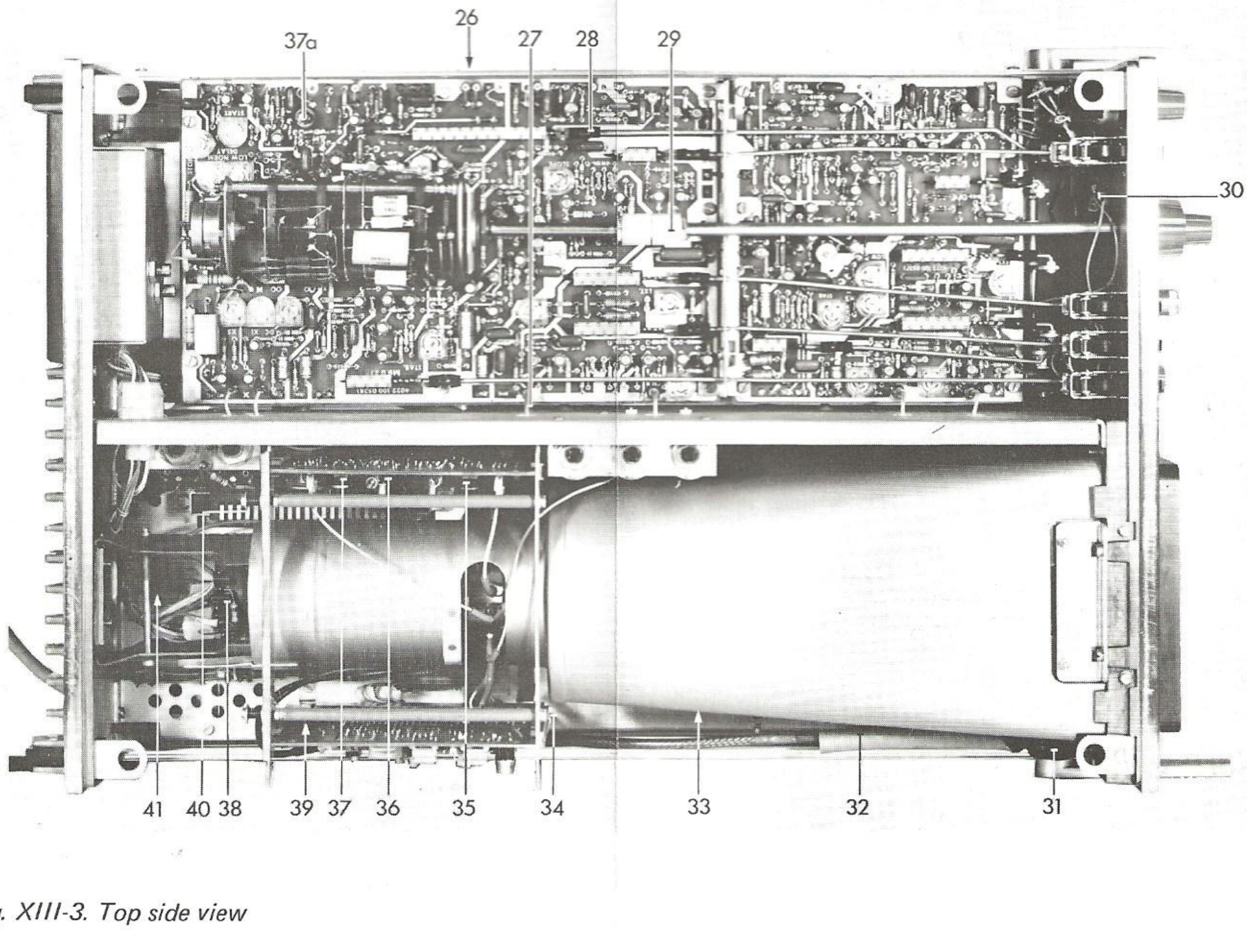



*Fig. XIII-3. Top side view*

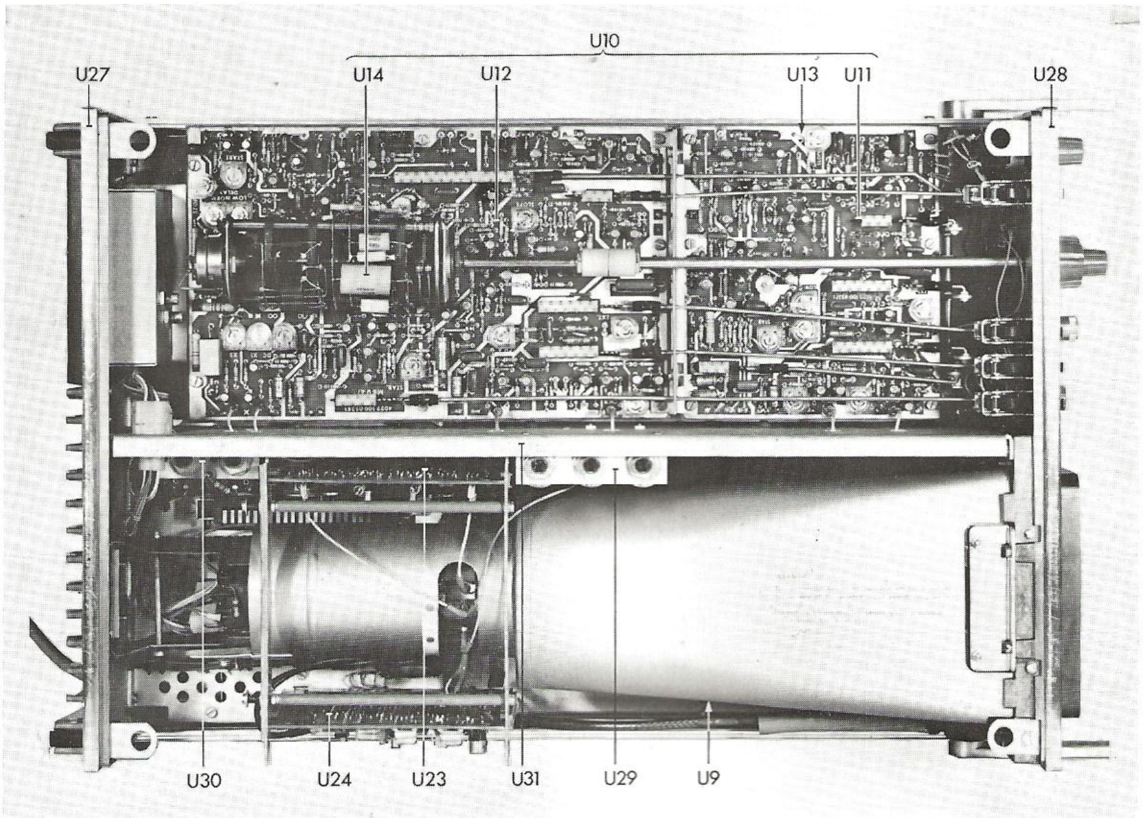



*Fig. XIII-4. Top side view*

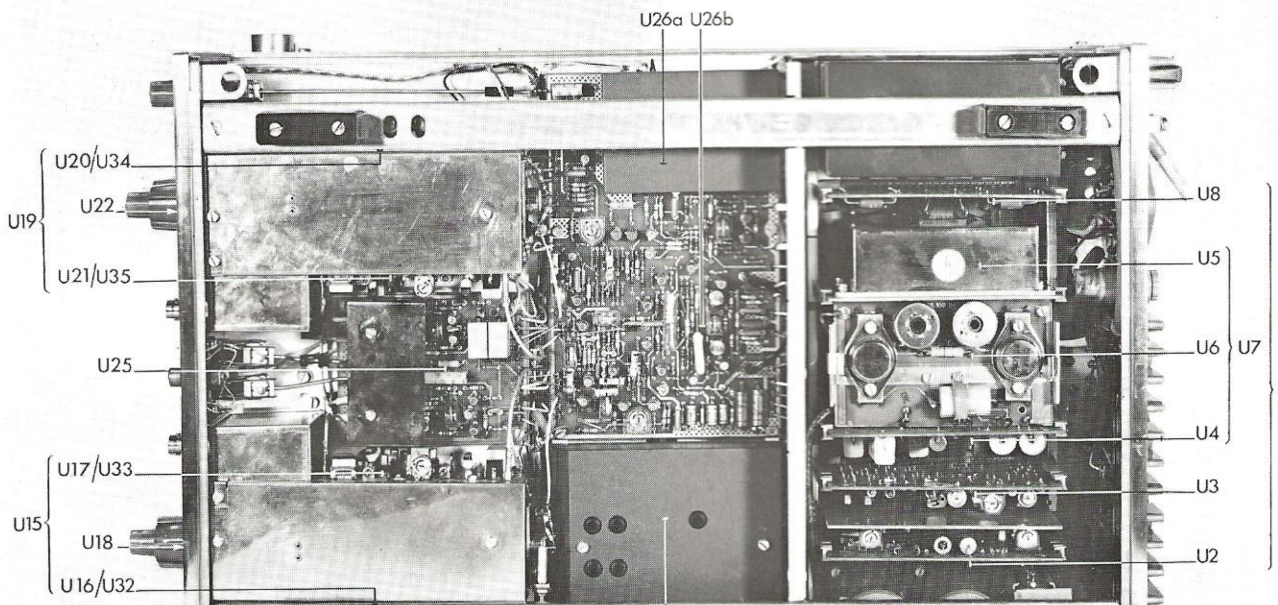



*Fig. XIII-5. Bottom side view*

## COMPLETE UNITS

| *Item* | *Fig.* | *Code number* | *Description* |
|---|---|---|---|
| U2 | XIII-5 | 5322 216 50142 | Supply panel |
| U3 | XIII-5 | 5322 216 54042 | Z-amplifier |
| U7 | XIII-5 | 5322 216 54043 | High voltage chopper unit complete |
| U8 | XIII-5 | 5322 216 50147 | Diode panel |
| U9 | XIII-4 | 5322 216 54045 | Calibration unit |
| U10 | XIII-4 | 5322 216 54047 | Time base, compl. |
| U13 | XIII-4 | 5322 273 80139 | D.T.B. switch SK11 |
| U14 | XIII-4 | 5322 273 80141 | M.T.B. switch SK7 |
| U15 | XIII-5 | 5322 218 64017 | Attenuator A compl. |
| U19 | XIII-5 | 5322 218 64018 | Attenuator B compl. |
| U23 | XIII-4 | 5322 216 54064 | Horizontal output amplifier |
| U24 | XIII-4 | 5322 216 54065 | Vertical output amplifier |
| U25 | XIII-5 | 5322 216 54066 | Trigger pick-off stage |
| U26a, b | XIII-5 | 5322 216 54067 | Intermediate amplifier |
| U36 | XIII-5 | 5322 216 54068 | Drift reduction circuit |
| U37 | XIII-5 | 5322 218 64019 | Modulator unit |
| U43 | | 5322 216 54062 | Line-Field sync. unit (PM 3250X) |

### PM 3250X

When ordering replacement units U10 (= U11 + U12) or U26a, b for the PM 3250X version, the above-mentioned code numbers must be ordered, but the circuit boards must be modified as described in chapter **IX.L.5.**

## SEMI CONDUCTORS

| *Type* | *Ordering code* | *Remarks* |
|---|---|---|
| **Diodes** | | |
| BA148 | 5322 130 30256 | |
| BAW62 | 5322 130 30613 | |
| BAX13 | 5322 130 40182 | |
| BAX16 | 5322 130 30273 | |
| BY127 | 5322 130 30259 | |
| BY176 | 5322 130 30588 | |
| OA95 | 4822 130 30191 | (PM 3250X) |
| OF319 | 5322 130 34192 | OF319 = BAV45 selected to $J_{forw.}$ less than 10 nA at $V_{forw.}$ = 450 mV ($T_{amb.}$ = 25 °C) |
| **Zener diodes** | | |
| BZX48 | 5322 130 30397 | $V_z$ = 6,45 V |
| BZX61/C8V2 | 5322 130 34115 | |
| BZX61/C15 | 5322 130 34172 | |
| BZX61/C30 | 5322 130 30743 | |
| BZX61/C47 | 5322 130 30565 | |
| BZX61/C68 | 5322 130 30431 | |
| BZY88/C5V1 | 5322 130 30284 | $V_{GR713 + GR714}$ must be equal to $V_{GR912 + GR913}$ (max. difference 0,1 V) |
| BZY88/C5V6 | 5322 130 30193 | |
| BZY88/C6V2 | 5322 130 30766 | |
| BZY88/C7V5 | 5322 130 30287 | |
| BZY88/C9V1 | 5322 130 30294 | |
| BZY94/C68 | 5322 130 30564 | |

| *Type* | *Ordering code* | *Remarks* |
|---|---|---|
| **Transistors** | | |
| | | *Outlines* |
| BC107 | 5322 130 40357 | TO-18 |
| BC109 | 5322 130 40144 | TO-18 |
| BC109C | 5322 130 40144 | TO-18 |
| BC177 | 4822 130 40522 | TO-18 |
| BC178 | 5322 130 40355 | TO-18 |
| BCY56 | 5322 130 40325 | TO-18 |
| BCY71 | 5322 130 40373 | TO-18 |
| BCY87 | 5322 130 40423 | TO-71 |
| BCY88 | 5322 130 30187 | TO-71 |
| BDY20 | 5322 130 40449 | TO-3 – TS1211 and TS1212 must be selected according to Serv. Inform. Cd 670 |
| BF179 | 5322 130 40661 | TO-5 |
| BFW10 | 5322 130 40443 | TO-72 (PM 3250X) |
| BFW44 | 5322 130 40672 | TO-39 |
| BFW45 | 5322 130 40652 | TO-39 |
| BFX48 | 5322 130 40208 | TO-18 |
| BFY90 | 5322 130 40493 | TO-72 |
| BSV81 | 5322 130 44041 | TO-72 |
| BSX20 | 5322 130 40417 | TO-18 |
| BSX29 | 5322 130 40205 | TO-18 |
| BSX59 | 5322 130 40124 | TO-39 |
| FW5324 | 5322 130 40142 | TO-18 |
| FW5435 | 5322 130 40186 | TO-18 |
| FW5497 | 5322 130 40673 | TO-5 |
| 2N1711 [1] | 5322 130 40019 | TO-39 |

[1] 2N1711 may be replaced by BSW66 (R1240, if used, must then be 6,8 kΩ).

**Integrated circuits**

| | | | |
|---|---|---|---|
| TAA521 | 5322 209 80068 | TO-99 | Equiv. 709C |

## VARIOUS ELECTRICAL PARTS

| *Item* | *Fig.* | *Code number* | *Description* |
|---|---|---|---|
| **Tubes, lamps** | | | |
| B1301, B1302 | XIV-19, 20 | 5322 131 90021 | Gas-filled tube ZA1004 |
| B1303* | XIII-6 | 5322 131 20013 | Cathode ray tube D14-160 GH/09 (medium short persistence type for PM 3250 and PM 3250X) |
| | | 5322 131 24016 | Cathode ray tube D14-160 GM/09 (long persistence type for PM 3250G) |
| LA1, LA2 | XIII-6 | 5322 134 40228 | Pilot lamp 12828 12 V 1,2 W |
| LA3 | XIII-6 | 5322 276 10398 | Lamp compl. with switch |
| LA4 | XIII-6 | 5322 134 40003 | Pilot lamp 7121D 6 V 0,05 A |
| LA5 | XIII-6 | 5322 134 40065 | Pilot lamp 8108D 24 V 0,05 A |

* The cathode ray tube is delivered complete with coils L1301 and L1302.

| Item | Fig. | Code number | Description |
|---|---|---|---|
| **Fuses** | | | |
| VL1 | XIII-7 | 4822 253 30021 | 1 A 'slow blow' (for 200 V, 220 V, 245 V) |
| VL1 | XIII-7 | 4822 253 30025 | 2 A 'slow blow' (for 110 V, 125 V) |
| VL2 | XIV-21 | 4822 252 20001 | Thermal fuse (138 °C), located in supply transformer T1201 |
| **Transformers** | | | |
| T501 | XIV-7 | 5322 158 10291 | Transformer of blocking oscillator |
| T1201 | XIV-21 | 5322 146 24006 | Power supply transformer |
| T1202 | XIV-21 | 5322 148 80014 | High tension transformer |
| **Switches** | | | |
| SK1 | XIV-16, 17 | 5322 277 30466 | Slide switch |
| SK2, SK16 | XIV-16, 17 | 5322 277 30468 | Slide switch |
| SK3, SK17 | XIV-16, 17 | 5322 277 30467 | Slide switch |
| SK4, SK15 | XIV-16, 17 | 5322 277 30409 | Slide switch |
| SK18, SK23 | | | |
| SK6 | XIII-6 | 5322 276 10398 | Switch compl. with lamp |
| SK7 | XIV-16 | 5322 273 80141 | Rotary switch, compl. |
| SK10 | XIV-18 | 5322 277 30469 | Slide switch |
| SK11 | XIV-17 | 5322 273 80139 | Rotary switch, compl. |
| SK13 | XIII-6 | 5322 276 10399 | Switch (without button) |
| SK14 | XIII-6 | 5322 277 10226 | Mains switch |
| SK20, SK25 | XIV-8,9 | 5322 277 30473 | Slide switch |
| SK21, SK24 | XIV-3, 4, 5, 6 | 5322 277 30472 | Slide switch |
| SK22 | XIV-8, 9 | 5322 277 30474 | Slide switch |
| SK28 | XIII-21 | 5322 272 10003 | Voltage adaptor |
| SK32, 33 | | 5322 276 54011 | Push button switch assy (PM 3250X) |
| Above mentioned slide switches are supplied without driving mechanism (see 'Mechnical Parts'), but with nylon fork. | | | |
| – | – | 5322 492 64079 | V-spring (fixing the nylon fork to the drive mechanism) |
| **Coils** | | | |
| L101, L102, L301, L302, L401, L402 | XIV-5, 6, 7 | 5322 158 10243 | R.F. choke 100 μH * |
| L501 | XIV-7 | 5322 320 40032 | Coaxial delay line, length approx. 45 cm |
| L502, L503 | XIV-15 | 5322 158 10276 | R.F. Choke 4,7 μH * |
| L601, L602 | XIV-14 | 5322 158 10284 | R.F. Choke 0,68 μH * |
| L603 | XIV-8, 9 | 5322 219 80158 | Delay line unit, complete 65 ns, char. imp. 50 Ω |
| L1201, L1202 | XIV-21 | 5322 158 20312 | Pot. core choke 0,7 mH 0,1 Ω |
| L1203, L1204 | XIV-21 | 5322 158 20235 | Pot. core choke 50 mH 10 Ω |
| L1301, L1302 | XIV-19, 20 | – | Part of c.r.t. assembly |
| **Relays** | | | |
| RE101 - ..... | | 5322 280 20007 | Reed relay, glass-tube contact only |
| | | 5322 281 60125 | Reed relay, coil only 12 V, 910 Ω |

* Value indicated by standard color code.

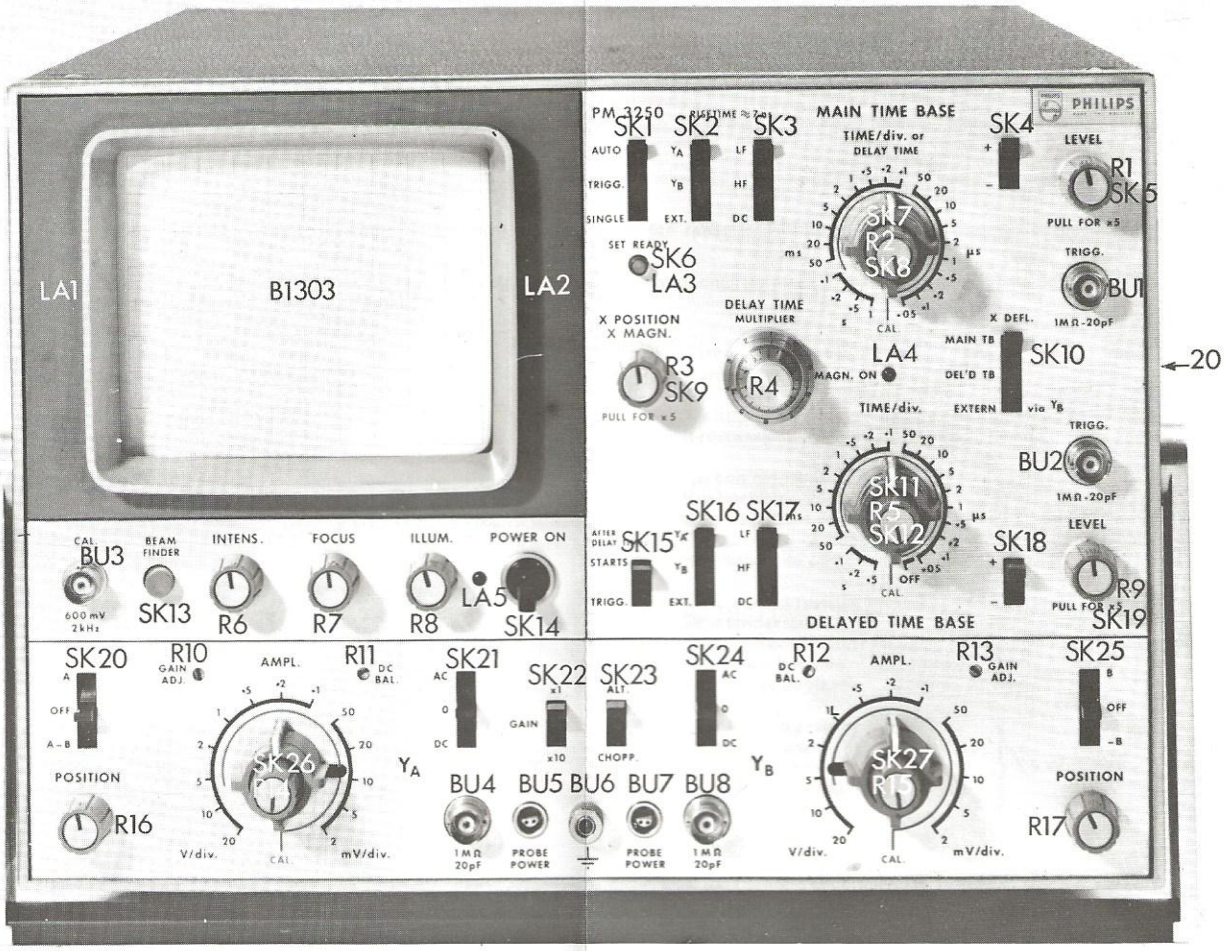



*Fig. XIII-6. Front side view*

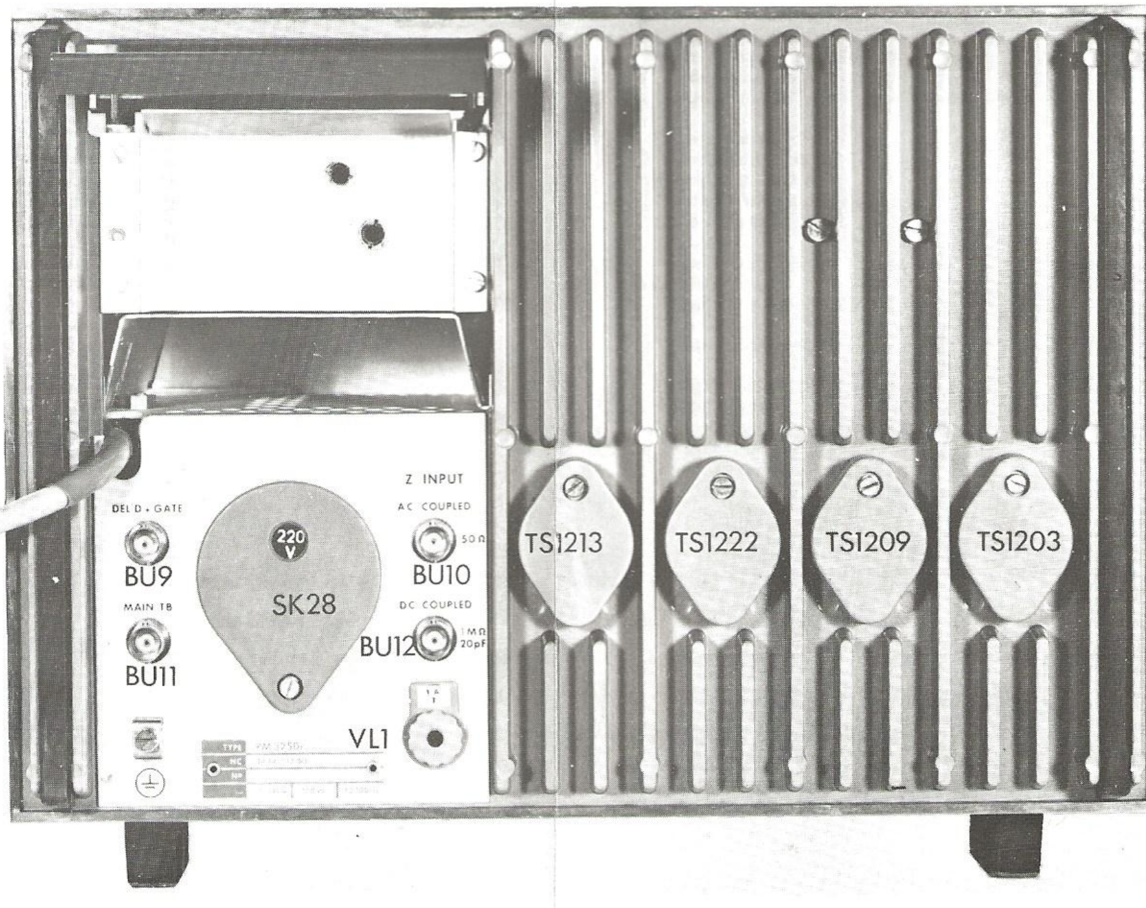



*Fig. XIII-7. Rear side view*

## B. ELECTRICAL — ELEKTRISCH — ELEKTRISCH — ELECTRIQUE — ELECTRICOS

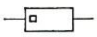
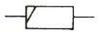
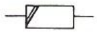
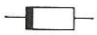
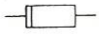
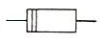
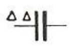
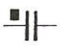
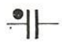
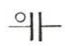
This parts list does not contain multi-purpose and standard parts. These components are indicated in the circuit diagram by means of identification marks. The specification can be derived from the survey below.

Diese Ersatzteilliste enthält keine Universal- und Standard-Teile. Diese sind im jeweiligen Prinzipschaltbild mit Kennzeichnungen versehen. Die Spezifikation kann aus nachstehender Übersicht abgeleitet werden.

In deze stuklijst zijn geen universele en standaardonderdelen opgenomen. Deze componenten zijn in het principeschema met een merkteken aangegeven. De specificatie van deze merktekens is hieronder vermeld.

La présente liste ne contient pas des pièces universelles et standard. Celles-ci ont été repérées dans le schéma de principe. Leurs specifications sont indiquées ci-dessous.

Esta lista de componentes no comprende componentes universales ni standard. Estos componentes están provistos en el esquema de principio de una marca. El significado de estas marcas se indica a continuación.

| | | |
|---|---|---|
|  | Carbon resistor E24 series<br>Kohleschichtwiderstand, Reihe E24<br>Koolweerstand E24 reeks<br>Résistance au carbone, série E24<br>Resistencia de carbón, serie E24 | 0,125 W 5% |
|  | Carbon resistor E12 series<br>Kohleschichtwiderstand, Reihe E12<br>Koolweerstand E12 reeks<br>Résistance au carbone, série E12<br>Resistencia de carbón, serie E12 | 0,25 W ≦ 1 MΩ, 5%<br>> 1 MΩ, 10% |
|  | Carbon resistor E24 series<br>Kohleschichtwiderstand, Reihe E24<br>Koolweerstand E24 reeks<br>Résistance au carbone, série E24<br>Resistencia de carbón, serie E24 | 0,5 W ≦ 5 MΩ, 1%<br>> 5 ≦ 10 MΩ, 2%<br>> 10 MΩ, 5% |
|  | Carbon resistor E12 series<br>Kohleschichtwiderstand, Reihe E12<br>Koolweerstand E12 reeks<br>Résistance au carbone, série E12<br>Resistencia de carbón, serie E12 | 0,5 W ≦1,5MΩ, 5%<br>>1,5MΩ, 10% |
|  | Carbon resistor E12 series<br>Kohleschichtwiderstand, Reihe E12<br>Koolweerstand E12 reeks<br>Résistance au carbone, série E12<br>Resistencia de carbón, serie E12 | 1 W ≦ 2,2 MΩ, 5%<br>> 2,2 MΩ, 10% |
|  | Carbon resistor E12 series<br>Kohleschichtwiderstand, Reihe E12<br>Koolweerstand E12 reeks<br>Résistance au carbone, série E12<br>Resistencia de carbón, serie E12 | 2 W 5% |
|  | Wire-wound resistor<br>Drahtwiderstand<br>Draadgewonden weerstand<br>Résistance bobinée<br>Resistencia bobinada | 0,4 – 1,8 W 0,5% |
|  | Wire-wound resistor<br>Drahtwiderstand<br>Draadgewonden weerstand<br>Résistance bobinée<br>Resistencia bobinada | 5,5 W ≦ 200 Ω, 10%<br>> 200 Ω, 5% |
|  | Wire-wound resistor<br>Drahtwiderstand<br>Draadgewonden weerstand<br>Résistance bobinée<br>Resistencia bobinada | 10 W 5% |
|  | Tubular ceramic capacitor<br>Rohrkondensator<br>Keramische kondensator, buistype<br>Condensateur céramique tubulaire<br>Condensador cerámico tubular | 500 V |
|  | Tubular ceramic capacitor<br>Rohrkondensator<br>Keramische kondensator, buistype<br>Condensateur céramique tubulaire<br>Condensador cerámico tubular | 700 V |
|  | Ceramic capacitor, "pin-up"<br>Keramikkondensator "Pin-up" (Perltyp)<br>Keramische kondensator "Pin-up" type<br>Condensateur céramique, type perle<br>Condensador cerámico, versión "colgable" | 500 V |
|  | "Microplate" ceramic capacitor<br>Miniatur-Scheibenkondensator<br>"Microplate" keramische kondensator<br>Condensateur céramique "microplate"<br>Condensador cerámico "microplaca" | 30 V |
|  | Mica capacitor<br>Glimmerkondensator<br>Micakondensator<br>Condensateur au mica<br>Condensador de mica | 500 V |
|  | Polyester capacitor<br>Polyesterkondensator<br>Polyesterkondensator<br>Condensateur au polyester<br>Condensador polyester | 400 V |
|  | Flat-foil polyester capacitor<br>Miniatur-Polyesterkondensator (flach)<br>Platte miniatuur polyesterkondensator<br>Condensateur au polyester, type plat<br>Condensador polyester, tipo de placas planas | 250 V |
|  | Paper capacitor<br>Papierkondensator<br>Papierkondensator<br>Condensateur au papier<br>Condensador de papel | 1000 V |
|  | Wire-wound trimmer<br>Drahttrimmer<br>Draadgewonden trimmer<br>Trimmer à fil<br>Trimmer bobinado | |
|  | Tubular ceramic trimmer<br>Rohrtrimmer<br>Buisvormige keramische trimmer<br>Trimmer céramique tubulaire<br>Trimmer cerámico tubular | |

SERVICE

For multi-purpose and standard parts, please see PHILIPS' Service Catalogue.
Für die Universal- und Standard-Teile siehe den PHILIPS Service-Katalog.
Voor universele en standaardonderdelen raadplege men de PHILIPS Service Catalogus.
Pour les pièces universelles et standard veuillez consulter le Catalogue Service PHILIPS.
Para piezas universales y standard consulte el Catálogo de Servicio PHILIPS.

**POTENTIOMETERS**

| *Item* | *Fig.* | *Ordering number* | Ω | % | *W* | *Remarks* |
|---|---|---|---|---|---|---|
| R1, R9 | XIII-6 | 5322 101 64001 | 22 k | | 1/4 | 23 Ø with switch |
| R2, R5 | XIII-6 | 5322 101 40043 | 22 k | 20 | 1/4 | 23 Ø |
| R3 | XIII-6 | 5322 101 64002 | 4,7 k | | 1/4 | 23 Ø with switch |
| R4 | XIII-6 | 5322 103 40045 | 5 k | | | ten-turn |
| R6 | XIII-6 | 5322 101 20362 | 220 k | 20 | 1/4 | |
| R7 | XIII-6 | 5322 101 20363 | 100 k | 20 | 1/4 | 23 Ø |
| R8 | XIII-6 | 5322 101 20323 | 10 k | 20 | 0,1 | 16 Ø |
| R10, R13 | XIII-6 | 5322 101 20358 | 50 | | 1 | |
| R11, R12 | XIII-6 | 5322 101 24034 | 50 k | | 1 | |
| R14, R15 | XIII-6 | 5322 101 20361 | 200 | | 1 | |
| R16, R17 | XIII-6 | 5322 101 20135 | 220 | 20 | 0,1 | 16 Ø |
| R119, R319 | XIV-3 | 5322 100 10155 | 250 | | | V |
| R122, R322 | XIV-3, 4 | 5322 100 10127 | 5 k | | | V |
| R141, R341 | XIV-3, 4 | 5322 100 10155 | 250 | | | V |
| R143, R343 | XIV-3, 4 | 5322 100 10128 | 100 | | | V |
| R462 | XIV-7 | 5322 100 10152 | 25 k | | | H |
| R468 | XIV-7 | 5322 100 10114 | 5 k | | | H |
| R475 | XIV-7 | 5322 100 10149 | 100 | | | H |
| R505, R525 | XIV-10 | 5322 100 10156 | 50 k | | | V |
| R632, R633 | XIV-6 | 5322 100 10126 | 2,5 k | | | H |
| R638, R642 | XIV-6 | 5322 100 10124 | 250 | | | H |
| R643 | XIV-6 | 5322 100 10151 | 1 k | | | H |
| R701, R714 | XIV-12 | 5322 100 10152 | 25 k | | | H |
| R733 | XIV-12 | 5322 100 10151 | 1 k | | | H |
| R772 | XIV-12 | 5322 100 10125 | 10 k | | | H |
| R807 | XIV-12 | 5322 100 10123 | 50 k | | | H |
| R819, R824 | XIV-12 | 5322 100 10152 | 25 k | | | H |
| R901, R914 | XIV-11 | 5322 100 10152 | 25 k | | | H |
| R933 | XIV-11 | 5322 100 10151 | 1 k | | | H |
| R957 | XIV-11 | 5322 100 10125 | 10 k | | | H |
| R1036 | XIV-11 | 5322 100 10123 | 50 k | | | H |
| R1049, R1052 | XIV-11 | 5322 100 10152 | 25 k | | | H |
| R1090 | XIV-11 | 5322 100 10153 | 100 k | | | H |
| R1094, R1109 | XIV-11 | 5322 100 10123 | 50 k | | | H |
| R1122 | XIV-11 | 5322 100 10125 | 10 k | | | H |
| R1123 | XIV-11 | 5322 100 10137 | 500 | | | H |
| R1159 | XIV-7 | 5322 100 10151 | 1 k | | | H |
| R1166 | XIV-7 | 5322 100 10123 | 50 k | | | H |
| R1208, R1242 | XIV-15 | 5322 100 10148 | 500 | | | V |
| R1256 | XIV-18 | 5322 100 10153 | 100 k | | | H |
| R1263 | XIV-18 | 5322 100 10154 | 500 k | | | H |
| R1321 | XIV-14 | 5322 101 14023 | 2,5 k | | | V |
| R1327 | XIV-15 | 5322 100 10153 | 100 k | | | H |
| R1328 | XIV-15 | 5322 101 14044 | 200 k | | | H |
| R1339 | XIV-14 | 5322 101 20064 | 220 k | 5 | 0,125 | |

V - Mounted vertically on p.c. board
H - Mounted horizontally on p.c. board

| *Item* | *Fig.* | *Ordering number* | *Ω* | *%* | *W* | *Remarks* |
|---|---|---|---|---|---|---|
| R1341 | XIV-14 | 5322 101 20112 | 47 k | 5 | 0,125 | |
| R1343, R1344 | XIV-14 | 5322 103 20091 | 4,7 k | 5 | 3 | |
| R1346 | XIV-14 | 5322 130 20094 | 10 k | 5 | 3 | |
| R1406, R1419 | XIV-7 | 5322 100 10123 | 50 k | | | H |
| R1602, R1607 | XIV-7 | 5322 100 10114 | 5 k | | | H |
| R1623 | XIV-7 | 5322 100 10124 | 250 | | | H |
| **PM 3250X** | | | | | | |
| R20 | XI-8 | 5322 101 20079 | 220 k | 20 | 0,1 | |
| R2116 | XIV-17 | 5322 100 10114 | 5 k | | 0,5 | H |
| R2152 | XIV-17 | 5322 100 10153 | 100 k | | 0,5 | H |

**CAPACITORS**

| *Item* | *Ordering number* | *F* | *%* | *V* | *Remarks* |
|---|---|---|---|---|---|
| C26...C29, C226...C229 | 5322 125 60067 | 8 p | | 500 | Trimmer |
| C31, C231 | 5322 123 10171 | 1,5 n | 5 | 300 | Disc |
| C32...C36, C232...C236 | 5322 125 60067 | 8 p | | 500 | Trimmer |
| C37, C237 | 5322 123 10222 | 390 p | | 300 | Disc |
| C38, C238 | 5322 125 60067 | 8 p | | 500 | Trimmer |
| C39, C239 | 5322 125 60068 | 4 p | | 500 | Trimmer |
| C41, C42, C241, C242 | 5322 125 60067 | 8 p | | 500 | Trimmer |
| C43, C243 | 5322 123 10223 | 68 p | 5 | 300 | Disc |
| C44, C244 | 5322 125 60067 | 8 p | | 500 | Trimmer |
| C45, C245 | 5322 123 10224 | 10 p | 20 | 300 | Disc |
| C46, C246 | 5322 125 60068 | 4 p | | 500 | Trimmer |
| C47, C48, C247, C248 | 5322 125 60067 | 8 p | | 500 | Trimmer |
| C49, C249 | 5322 123 10224 | 10 p | 20 | 300 | Disc |
| C51, C52, C251, C252 | 5322 125 60067 | 8 p | | 500 | Trimmer |
| C53, C253 | 5322 125 60068 | 4 p | | 500 | Trimmer |
| C54, C254 | 5322 122 10096* | 82 p | 1 | 500 | Cer. tubular |
| C55, C255 | 5322 125 60067 | 8 p | | 500 | Trimmer |
| C56, C256 | 5322 125 60068 | 4 p | | 500 | Trimmer |
| C57, C257 | 5322 122 10096* | 82 p | 1 | 500 | Cer. tubular |
| C58, C258 | 5322 125 60068 | 4 p | | 500 | Trimmer |
| C59,C259 | 5322 122 10096* | 82 p | 1 | 500 | Cer. tubular |
| C60, C260 | 5322 125 60067 | 8 p | | 500 | Trimmer |
| C61, C261 | 5322 125 60068 | 4 p | | 500 | Trimmer |
| C62, C262 | 5322 122 10096* | 82 p | 1 | 500 | Cer. tubular |
| C63, C64, C263, C264 | 5322 125 60067 | 8 p | | 500 | Trimmer |
| C101, C301 | 5322 121 40145 | 100 n | 20 | 630 | Polyester |
| C103, C303 | 5322 122 30006 | 10 | 2 | 63 | Cer. plate |
| C104, C304 | 5322 122 30033 | 4,7 p | ±1/4 pF | 63 | Cer. plate |
| C106, C306 | 5322 122 30103 | 22 n | −20 +100 | 40 | Cer. plate |
| C107, C307 | 5322 124 20373 | 47 μ | | 10 d.c. | Electrolytic |

* These capacitors must be selected within a tolerance of 0,5 %.

| Item | Ordering number | F | % | V | Remarks |
|---|---|---|---|---|---|
| C108, C308 | 5322 125 50047 | 3 p | | 400 | Trimmer |
| C109, C309 | 5322 122 30103 | 22 n | –20 +100 | 40 | Cer. plate |
| C112, C312 | 4822 125 60027 | 6 p | | 400 | Trimmer |
| C114, C314 | 5322 121 40233 | 680 n | 10 | 100 | Polyester |
| C116, C316 | 5322 121 40256 | 2,2 μ | 10 | 100 | Polyester |
| C117, C317 | 5322 122 30103 | 22 n | –20 +100 | 40 | Cer. plate |
| C118, C318 | 4822 122 31175 | 1 k | 10 | 100 | Cer. plate |
| C119, C319 | 4822 122 30104 | 1 p | ±1/4 pF | 63 | Cer. plate |
| C121, C321 | 5322 122 30045 | 27 p | 2 | 63 | Cer. plate |
| C122, C322 | 5322 122 30103 | 22 n | –20 +100 | 40 | Cer. plate |
| C124, C324 | 4822 122 30104 | 1 p | ±1/4 pF | 63 | Cer. plate |
| C128 | 5322 125 64001 | 12 p | | 400 | Trimmer |
| C130, C330 | 5322 125 50048 | 3 p | | 400 | Trimmer |
| C131, C331 | 5322 124 20407 | 400 μ | –10 +50 | 25 d.c. | Electrolytic |
| C132, C332 | 5322 124 20355 | 10 μ | –10 +50 | 25 d.c. | Electrolytic |
| C133, C333 | 5322 122 30034 | 470 p | 2 | 63 | Cer. plate |
| C136, C336 | 5322 122 30043 | 10 n | –20 +100 | 40 | Cer. plate |
| C137, C337 | 5322 122 30103 | 22 n | –20 +100 | 40 | Cer. plate |
| C408 | 5322 125 60069 | 6 p | | 400 | Trimmer |
| C417, C418 | 4822 125 50061 | 5,5 p | | 100 | Trimmer |
| C419, C421 | 4822 124 20366 | 25 μ | –10 +50 | 25 d.c. | Electrolytic |
| C426, C427 | 4822 124 20368 | 33 μ | | 16 d.c. | Electrolytic |
| C505 | 5322 122 30005 | 8,2 p | ±1/4 pF | 63 | Cer. plate |
| C506, C507 | 5322 122 30023 | 68 p | 2 | 63 | Cer. plate |
| C510 | 5322 122 30005 | 8,2 p | ±1/4 pF | 63 | Cer. plate |
| C513, C514 | 5322 122 30023 | 68 p | 2 | 63 | Cer. plate |
| C516, C517 | 5322 122 30022 | 22 p | 2 | 63 | Cer. plate |
| C518, C519 | 5322 122 30016 | 33 p | 2 | 63 | Cer. plate |
| C524 | 5322 122 30022 | 22 p | 2 | 63 | Cer. plate |
| C527 | 5322 122 30023 | 68 p | 2 | 63 | Cer. plate |
| C528 | 5322 122 30034 | 470 p | 2 | 63 | Cer. plate |
| C600, C605 | 5322 122 30023 | 68 p | 2 | 63 | Cer. plate |
| C700, C702 | 5322 122 30043 | 10 n | –20 +100 | 40 | Cer. plate |
| C704, C705 | 5322 122 30043 | 10 n | –20 +100 | 40 | Cer. plate |
| C706 | 4822 120 10045 | 4,7 p | ±1/2 pF | 500 | Cer. tubular |
| C707 | 4822 120 10056 | 12 p | 5 | 500 | Cer. tubular |
| C708 | 5322 121 40145 | 100 n | 10 | 630 | Polyester |
| C709, C710 | 5322 124 10152 | 18 μ | 20 | 15 d.c. | Tantalum |
| C712 | 5322 122 34005 | 330 p | 10 | 100 | Cer. plate |
| C716, C717 | 5322 122 30021 | 100 p | 2 | 63 | Cer. plate |
| C719 | 5322 122 30021 | 100 p | 2 | 63 | Cer. plate |
| C721 | 5322 122 30016 | 33 p | 2 | 63 | Cer. plate |
| C722 | 5322 122 30021 | 100 p | 2 | 63 | Cer. plate |
| C727 | 5322 122 30022 | 22 p | 2 | 63 | Cer. plate |
| C729 | 5322 122 30015 | 82 p | 2 | 63 | Cer. plate |
| C731 | 5322 122 30116 | 56 p | 2 | 63 | Cer. plate |
| C732 | 4822 122 30032 | 12 p | 2 | 63 | Cer. plate |
| C734 | 5322 125 50017 | 65 p | | 100 | Trimmer |
| C735 | 5322 122 30045 | 27 p | 2 | 63 | Cer. plate |
| C738 | 5322 122 30027 | 1 n | 10 | 100 | Cer. plate |
| C743, C744 | 4822 124 20368 | 33 μ | | 16 d.c. | Electrolytic |
| C746 | 5322 124 20355 | 10 μ | –10 +50 | 25 d.c. | Electrolytic |
| C851 | 5322 121 50479 | 160 n | 1/2 | 63 | Polystyrene |
| C852 | 5322 121 50481 | 15,9 n | 1/2 | 63 | Polystyrene |

| *Item* | *Ordering number* | *F* | | *%* | *V* | *Remarks* |
|---|---|---|---|---|---|---|
| C853 | 5322 123 10225 | 1,5 | n | 1/2 | 125 | Mica |
| C854 | 5322 123 10226 | 240 | p | 1/2 | 125 | Mica |
| C856 | 5322 124 14025 | 18 | μ | | 35 d.c. | Tantalum |
| C857 | 4822 120 10063 | 22 | p | 5 | 500 | Cer. tubular |
| C871 | 5322 124 14025 | 18 | μ | | 35 d.c. | Tantalum |
| C872 | 5322 123 10226 | 240 | p | 1/2 | 125 | Mica |
| C873 | 5322 123 10225 | 1,5 | n | 1/2 | 125 | Mica |
| C874 | 5322 121 50481 | 15,9 | n | 1/2 | 63 | Polystyrene |
| C875 | 4822 120 10063 | 22 | p | 5 | 500 | Cer. tubular |
| C876 | 5322 121 50479 | 160 | n | 1/2 | 63 | Polystyrene |
| C877 | 5322 124 10004 | 10 | μ | | 20 d.c. | Tantalum |
| C878 | 4822 120 10076 | 68 | p | 5 | 500 | Cer. tubular |
| C879 | 4822 120 20107 | 1 | n | −20 +50 | 500 | Cer. tubular |
| C881 | 5322 121 40088 | 10 | n | 10 | 250 | Polyester |
| C882 | 5322 121 40036 | 100 | n | 10 | 250 | Polyester |
| C900, C902 | 5322 122 30043 | 10 | n | −20 +50 | 40 | Cer. plate |
| C904, C905 | 5322 122 30043 | 10 | n | −20 +50 | 40 | Cer. plate |
| C906 | 4822 120 10054 | 10 | p | ±1/2 pF | 500 | Cer. tubular |
| C907 | 5322 121 40145 | 100 | n | 10 | 630 | Polyester |
| C908 | 4822 120 10049 | 6,8 | p | ±1/2 pF | 500 | Cer. tubular |
| C909, C911 | 5322 124 10152 | 18 | μ | 20 | 15 d.c. | Tantalum |
| C913 | 5322 122 34005 | 330 | p | 10 | 100 | Cer. plate |
| C915 | 5322 122 30016 | 33 | p | 2 | 63 | Cer. plate |
| C916, C917 | 5322 122 30021 | 100 | p | 2 | 63 | Cer. plate |
| C919, C921 | 5322 122 30021 | 100 | p | 2 | 63 | Cer. plate |
| C923 | 5322 122 30027 | 1 | n | 10 | 100 | Cer. plate |
| C924 | 5322 124 10008 | 22 | μ | 20 | 35 d.c. | Tantalum |
| C927 | 5322 122 30022 | 22 | p | 2 | 63 | Cer. plate |
| C928 | 4822 122 30023 | 68 | p | 2 | 63 | Cer. plate |
| C929 | 5322 122 30116 | 56 | p | 2 | 63 | Cer. plate |
| C931 | 5322 122 30015 | 82 | p | 2 | 63 | Cer. plate |
| C932 | 5322 122 30021 | 100 | p | 2 | 63 | Cer. plate |
| C934 | 5322 122 30097 | 15 | p | 2 | 63 | Cer. plate |
| C935 | 5322 122 30045 | 27 | p | 2 | 63 | Cer. plate |
| C937 | 5322 120 50017 | 65 | p | | 100 | Trimmer |
| C940 | 5322 122 30027 | 1 | n | 10 | 100 | Cer. plate |
| C948, C949 | 4822 124 20368 | 33 | μ | | 16 d.c. | Electrolytic |
| C951 | 5322 124 20355 | 10 | μ | −10 +50 | 25 d.c. | Electrolytic |
| C1176, C1178 | 5322 125 50047 | 3 | p | | 400 | Trimmer |
| C1200 | 5322 121 20173 | 100 | n | 20 | 250 | |
| C1201 | 5322 124 70235 | 2x5 | m par. *) | −10 +50 | 40 d.c. | Electrolytic |
| C1203, C1204 | 5322 124 10108 | 47 | μ | 20 | 35 d.c. | Tantalum |
| C1205 | 5322 121 50478 | 30 | n | 5 | 250 | Polystyrene |
| C1206 | 5322 124 70235 | 2x5 | m par. *) | −10 +50 | 40 d.c. | Electrolytic |
| C1207, C1208, C1209 | 5322 124 20029 | 25 | μ | −10 +30 | 300 d.c. | Electrolytic |
| C1210 | 5322 121 44092 | 47 | n | 20 | 250 | |
| C1211 | 5322 124 20029 | 25 | μ | −10 +30 | 300 d.c. | Electrolytic |
| C1213 | 5322 124 10108 | 47 | μ | 20 | 35 d.c. | Tantalum |
| C1214 | 4822 124 20539 | 32 | μ | −10 +30 | 150 d.c. | Electrolytic |
| C1215 | 5322 121 44092 | 47 | n | 20 | 250 | |

*) Note: 1 mF = 1000 μF

| Item | Ordering number | F | % | V | Remarks |
|---|---|---|---|---|---|
| C1216 | 4822 124 20539 | 32 μ | −10 +30 | 150 d.c. | Electrolytic |
| C1217, C1218 | 5322 121 40195 | 33 n | 10 | 1600 | Polyester |
| C1219...C1223 | 5322 121 30077 | 500 p | −20 +50 | 10 k | High tension |
| C1225 | 5322 124 10073 | 6,8 μ | 20 | 35 d.c. | Tantalum |
| C1226 | 5322 121 50421 | 160 n | 1 | 63 | Polystyrene |
| C1228 | 5322 122 30091 | 390 p | 2 | 63 | Cer. plate |
| C1229, C1231 | 5322 122 30103 | 22 n | −20 +100 | 40 | Cer. plate |
| C1300 | 5322 122 30109 | 1,5 p | ±1/4 pF | 63 | Cer. plate |
| C1301 | 5322 122 40068 | 1,2 p | ±1/4 pF | 500 | Cer. disc |
| C1302, C1303 | 5322 124 10153 | 22 μ | 20 | 15 d.c. | Tantalum |
| C1304 | 5322 124 20059 | 6,4 μ | −10 +30 | 150 d.c. | Electrolytic |
| C1306, C1307 | 5322 125 50047 | 3 p | | 400 | Trimmer |
| C1308 | 5322 124 20059 | 6,4 μ | −10 +30 | 150 d.c. | Electrolytic |
| C1311 | 5322 121 40326 | 6,8 n | 10 | 1600 | Polyester |
| C1314, C1316 | 5322 121 40195 | 33 n | 10 | 1600 | Polyester |
| C1317 | 5322 121 40279 | 68 n | 10 | 630 | Polyester |
| C1318 | 5322 121 40012 | 100 n | 10 | 400 | Polyester |
| C1319 | 5322 121 40195 | 33 n | 10 | 1600 | Polyester |
| C1320 | 5322 122 30027 | 1 n | 10 | 100 | Cer. plate |
| C1321 | 5322 121 44014 | 100 n | 10 | 100 | Polyester |
| C1401 | 4822 122 30032 | 12 p | 2 | 63 | Cer. plate |
| C1402 | 4822 122 30022 | 22 p | 2 | 63 | Cer. plate |
| C1403 | 5322 125 50049 | 9 p | | 500 | Trimmer |
| C1407 | 5322 124 10005 | 3,3 μ | 20 | 15 d.c. | Tantalum |
| C1408 | 5322 122 30006 | 10 p | 2 | 63 | Cer. plate |
| C1409 | 4822 122 30011 | 2,2 p | ±1/4 p | 63 | Cer. plate |
| C1416 | 5322 121 40252 | 6,8 μ | 10 | 100 | Polyester |
| C1419 | 4822 122 30032 | 12 p | 2 | 63 | Cer. plate |
| C1421 | 4822 122 30022 | 22 p | 2 | 63 | Cer. plate |
| C1422 | 5322 125 50049 | 9 p | | 500 | Trimmer |
| C1426 | 5322 124 10005 | 3,3 μ | 20 | 15 d.c. | Tantalum |
| C1427 | 5322 122 30006 | 10 p | 2 | 63 | Cer. plate |
| C1428 | 4822 121 30011 | 2,2 p | ±1/4 pF | 63 | Cer. plate |
| C1433 | 5322 121 40252 | 6,8 μ | 10 | 100 | Polyester |
| C1437 | 4822 124 20368 | 33 μ | | 16 d.c. | Electrolytic |
| C1438, C1439 | 5322 124 20355 | 10 μ | | 25 d.c. | Electrolytic |
| C1601 | 5322 125 60069 | 6 p | | 400 | Trimmer |
| **PM 3250X** | | | | | |
| C2101 | 5322 124 10008 | 22 μ | | 35 d.c. | Tantalum |
| C2102, C2104 | 5322 124 10058 | 2,2 μ | | 35 d.c. | Tantalum |
| C2106 | 5322 124 10018 | 2,2 μ | | 20 d.c. | Tantalum |
| C2109 | 5322 124 10162 | 4,7 μ | | 25 d.c. | Tantalum |
| C2113 | 4822 121 40212 | 330 n | 10 | 400 | Polyester |
| C2114 | 5322 124 10073 | 6,8 μ | | 35 d.c. | Tantalum |
| C2121 | 5322 124 10008 | 22 μ | | 35 d.c. | Tantalum |
| C2123 | 5322 121 40146 | 0,1 μ | 10 | 400 | Polyester |
| C2124 | 4822 122 30028 | 56 p | 2 | 63 | Cer. plate |
| C2127 | 5322 124 10073 | 6,8 μ | | 35 d.c. | Tantalum |
| C2128 | 5322 122 30045 | 27 p | 2 | 63 | Cer. plate |
| C2129 | 5322 125 50049 | 10 p | | 300 | Trimmer |
| C2131 | 4822 124 20369 | 47 μ | | 25 d.c. | Electrolytic |
| C2132 | 5322 124 10073 | 6,8 μ | | 35 d.c. | Tantalum |

| *Item* | *Ordering number* | *F* | *%* | *V* | *Remarks* |
|---|---|---|---|---|---|
| C1216 | 4822 124 20539 | 32 µ | −10 +30 | 150 d.c. | Electrolytic |
| C1217, C1218 | 5322 121 40195 | 33 n | 10 | 1600 | Polyester |
| C1219...C1223 | 5322 121 30077 | 500 p | −20 +50 | 10 k | High tension |
| C1225 | 5322 124 10073 | 6,8 µ | 20 | 35 d.c. | Tantalum |
| C1226 | 5322 121 50421 | 160 n | 1 | 63 | Polystyrene |
| C1228 | 5322 122 30091 | 390 p | 2 | 63 | Cer. plate |
| C1229, C1231 | 5322 122 30103 | 22 n | −20 +100 | 40 | Cer. plate |
| C1300 | 5322 122 30109 | 1,5 p | ±1/4 pF | 63 | Cer. plate |
| C1301 | 5322 122 40068 | 1,2 p | ±1/4 pF | 500 | Cer. disc |
| C1302, C1303 | 5322 124 10153 | 22 µ | 20 | 15 d.c. | Tantalum |
| C1304 | 5322 124 20059 | 6,4 µ | −10 +30 | 150 d.c. | Electrolytic |
| C1306, C1307 | 5322 125 50047 | 3 p | | 400 | Trimmer |
| C1308 | 5322 124 20059 | 6,4 µ | −10 +30 | 150 d.c. | Electrolytic |
| C1311 | 5322 121 40326 | 6,8 n | 10 | 1600 | Polyester |
| C1314, C1316 | 5322 121 40195 | 33 n | 10 | 1600 | Polyester |
| C1317 | 5322 121 40279 | 68 n | 10 | 630 | Polyester |
| C1318 | 5322 121 40012 | 100 n | 10 | 400 | Polyester |
| C1319 | 5322 121 40195 | 33 n | 10 | 1600 | Polyester |
| C1320 | 5322 122 30027 | 1 n | 10 | 100 | Cer. plate |
| C1321 | 5322 121 44014 | 100 n | 10 | 100 | Polyester |
| C1401 | 4822 122 30032 | 12 p | 2 | 63 | Cer. plate |
| C1402 | 4822 122 30022 | 22 p | 2 | 63 | Cer. plate |
| C1403 | 5322 125 50049 | 9 p | | 500 | Trimmer |
| C1407 | 5322 124 10005 | 3,3 µ | 20 | 15 d.c. | Tantalum |
| C1408 | 5322 122 30006 | 10 p | 2 | 63 | Cer. plate |
| C1409 | 4822 122 30011 | 2,2 p | ±1/4 p | 63 | Cer. plate |
| C1416 | 5322 121 40252 | 6,8 µ | 10 | 100 | Polyester |
| C1419 | 4822 122 30032 | 12 p | 2 | 63 | Cer. plate |
| C1421 | 4822 122 30022 | 22 p | 2 | 63 | Cer. plate |
| C1422 | 5322 125 50049 | 9 p | | 500 | Trimmer |
| C1426 | 5322 124 10005 | 3,3 µ | 20 | 15 d.c. | Tantalum |
| C1427 | 5322 122 30006 | 10 p | 2 | 63 | Cer. plate |
| C1428 | 4822 121 30011 | 2,2 p | ±1/4 pF | 63 | Cer. plate |
| C1433 | 5322 121 40252 | 6,8 µ | 10 | 100 | Polyester |
| C1437 | 4822 124 20368 | 33 µ | | 16 d.c. | Electrolytic |
| C1438, C1439 | 5322 124 20355 | 10 µ | | 25 d.c. | Electrolytic |
| C1601 | 5322 125 60069 | 6 p | | 400 | Trimmer |
| **PM 3250X** | | | | | |
| C2101 | 5322 124 10008 | 22 µ | | 35 d.c. | Tantalum |
| C2102, C2104 | 5322 124 10058 | 2,2 µ | | 35 d.c. | Tantalum |
| C2106 | 5322 124 10018 | 2,2 µ | | 20 d.c. | Tantalum |
| C2109 | 5322 124 10162 | 4,7 µ | | 25 d.c. | Tantalum |
| C2113 | 4822 121 40212 | 330 n | 10 | 400 | Polyester |
| C2114 | 5322 124 10073 | 6,8 µ | | 35 d.c. | Tantalum |
| C2121 | 5322 124 10008 | 22 µ | | 35 d.c. | Tantalum |
| C2123 | 5322 121 40146 | 0,1 µ | 10 | 400 | Polyester |
| C2124 | 4822 122 30028 | 56 p | 2 | 63 | Cer. plate |
| C2127 | 5322 124 10073 | 6,8 µ | | 35 d.c. | Tantalum |
| C2128 | 5322 122 30045 | 27 p | 2 | 63 | Cer. plate |
| C2129 | 5322 125 50049 | 10 p | | 300 | Trimmer |
| C2131 | 4822 124 20369 | 47 µ | | 25 d.c. | Electrolytic |
| C2132 | 5322 124 10073 | 6,8 µ | | 35 d.c. | Tantalum |

**RESISTORS**

| *Item* | *Ordering number* | Ω | | % | *Style* |
|---|---|---|---|---|---|
| R26, R226 | 5322 116 50777 | 999 | k | 1/2 | |
| R27, R227 | 5322 116 50798 | 898 | | 1/2 | MR31C |
| R28, R228 | 5322 116 50776 | 998 | k | 1/2 | |
| R29, R229 | 5322 116 50781 | 1,82 | k | 1/2 | MR31C |
| R31, R231 | 5322 116 50775 | 996 | k | 1/2 | |
| R32, R232 | 5322 116 50789 | 3,61 | k | 1/2 | MR31C |
| R33, R233 | 5322 116 50774 | 991 | k | 1/2 | |
| R34, R234 | 5322 116 50801 | 9,2 | k | 1/2 | MR31C |
| R36, R236 | 5322 116 50773 | 982 | k | 1/2 | |
| R37, R237 | 5322 116 54052 | 18,7 | k | 1/2 | MR31C |
| R38, R238 | 5322 116 50772 | 964 | k | 1/2 | |
| R39, R239 | 5322 116 50792 | 38,8 | k | 1/2 | MR31C |
| R41, R241 | 5322 116 50771 | 910 | k | 1/2 | |
| R42, R242 | 5322 116 50244 | 100 | k | 1/2 | MR39C |
| R43, R243 | 5322 116 50769 | 820 | k | 1/2 | |
| R44, R244 | 5322 116 54197 | 223 | k | 1/2 | MR39C |
| R46, R246 | 5322 116 50768 | 640 | k | 1/2 | |
| R47, R247 | 5322 116 54198 | 600 | k | 1/2 | |
| R48, R49, R248, R249 | 5322 116 54155 | 100 | k | 1/2 | MR31C |
| R51, R52, R251, R252 | 5322 116 54155 | 100 | k | 1/2 | MR31C |
| R101, R301 | 5322 111 30273 | 10 | k | 5 | CR16 |
| R102, R302 | 5322 111 30396 | 22 | | 5 | CR16 |
| R107, R108, R307, R308 | 5322 111 30275 | 15 | k | 5 | CR16 |
| R109, R309 | 5322 111 30399 | 33 | | 5 | CR16 |
| R111, R311 | 4822 111 30324 | 100 | | 5 | CR16 |
| R114, R314 | 4822 111 30324 | 100 | | 5 | CR16 |
| R118, R318 | 4822 111 30264 | 2,7 | k | 5 | CR16 |
| R120, R320 | 5322 111 54199 | 898 | k | 1/4 | MR58C |
| R123, R323, R125, R325 | 5322 116 54378 | 5,6 | M | 1 | |
| R126, R326 | 4822 111 30325 | 150 | | 5 | CR16 |
| R127, R327 | 4822 111 30324 | 100 | | 5 | CR16 |
| R129, R329 | 5322 116 50345 | 665 | | 1/4 | MR31C |
| R131, R331 | 5322 116 50784 | 2,67 | k | 1/4 | MR31C |
| R132, R332 | 5322 116 50794 | 4,32 | k | 1/4 | MR31C |
| R133, R333 | 5322 116 50788 | 332 | | 1/4 | MR24C |
| R134, R334 | 5322 111 54199 | 898 | k | 1/4 | MR58C |
| R137, R337 | 5322 116 50965 | 1,21 | k | 1 | MR25 |
| R138, R338 | 5322 111 30074 | 56 | | 5 | CR16 |
| R139, R339 | 5322 111 30356 | 43 | | 5 | CR16 |
| R140, R340 | 5322 111 30074 | 56 | | 5 | CR16 |
| R142, R342 | 5322 111 30074 | 56 | | 5 | CR16 |
| R144, R343 | 5322 116 50831 | 806 | | 1/4 | MR31C |
| R148, R348 | 5322 116 50788 | 332 | | 1/4 | MR24C |
| R149, R349 | 4822 111 30324 | 100 | | 5 | CR16 |
| R151, R351 | 5322 116 50779 | 1,33 | k | 1/4 | MR31C |
| R152, R352 | 5322 116 50831 | 806 | | 1/4 | MR31C |
| R153, R353 | 5322 111 30074 | 56 | | 5 | CR16 |
| R154, R354 | 5322 111 30356 | 43 | | 5 | CR16 |
| R156, R356 | 5322 116 50965 | 1,21 | k | 1 | MR25 |
| R157, R357 | 5322 111 30074 | 56 | | 5 | CR16 |

| *Item* | *Ordering number* | Ω | % | *Style* |
|---|---|---|---|---|
| R160, R360 | 5322 111 30074 | 56 | 5 | CR16 |
| R163, R363 | 4822 111 30324 | 100 | 5 | CR16 |
| R164, R364 | 4822 111 30324 | 100 | 5 | CR16 |
| R165, R365 | 5322 111 30074 | 56 | 5 | CR16 |
| R167, R367 | 4822 111 30351 | 750 | 5 | CR16 |
| R168, R368 | 5322 111 30288 | 47 k | 5 | CR16 |
| R169, R369 | 5322 111 30289 | 56 k | 5 | CR16 |
| R171, R371 | 5322 111 30288 | 47 k | 5 | CR16 |
| R172, R372 | 4822 111 30327 | 220 | 5 | CR16 |
| R173, R373 | 5322 111 30074 | 56 | 5 | CR16 |
| R174, R374 | 5322 116 54183 | 383 | 1 | MR25 |
| R175, R375 | — | — | 5 | CR16 |
| R176, R376 | 5322 116 50962 | 825 | 1 | MR25 |
| R179, R379 | 5322 111 30074 | 56 | 5 | CR16 |
| R182, R382 | 4822 111 30327 | 220 | 5 | CR16 |
| R183, R383 | 5322 116 50748 | 10 k | 1/4 | MR24C |
| R184, R384 | 5322 116 50381 | 1,78 k | 1 | MR30 |
| R187, R387 | 4822 111 30324 | 100 | 5 | CR16 |
| R189, R389 | 5322 116 50765 | 909 | 1 | MR30 |
| R409 | 5322 111 30269 | 1 k | 5 | CR16 |
| R411, R419 | 4822 111 30324 | 100 | 5 | CR16 |
| R420 | 5322 111 30074 | 56 | 5 | CR16 |
| R421, R422 | 5322 111 30269 | 1 k | 5 | CR16 |
| R423 | 5322 116 50524 | 3,01 k | 1 | MR25 |
| R424 | 5322 111 30074 | 56 | 5 | CR16 |
| R426 | 5322 116 50635 | 1,47 k | 1 | MR25 |
| R427 | 5322 111 30347 | 10 | 5 | CR16 |
| R430 | 4822 111 30324 | 100 | 5 | CR16 |
| R432 | 5322 111 30347 | 10 | 5 | CR16 |
| R433 | 5322 116 50635 | 1,47 k | 1 | MR25 |
| R434 | 5322 111 30074 | 56 | 5 | CR16 |
| R435 | 4822 111 30324 | 100 | 5 | CR16 |
| R436 | 5322 116 50524 | 3,01 k | 1 | MR25 |
| R437 | 5322 116 51056 | 11 k | 1 | MR25 |
| R438 | 5322 116 50979 | 8,25 k | 1 | MR25 |
| R439, R441 | 5322 111 30074 | 56 | 5 | CR16 |
| R442 | 5322 116 54171 | 2,21 k | 1 | MR25 |
| R445, R447 | 5322 116 54056 | 187 | 1 | MR25 |
| R448, R453 | 5322 116 50669 | 205 | 1 | MR25 |
| R454 | 5322 111 30074 | 56 | 5 | CR16 |
| R456 | 5322 116 50979 | 8,25 k | 1 | MR25 |
| R457 | 5322 111 30074 | 56 | 5 | CR16 |
| R458 | 5322 116 54171 | 2,21 k | 1 | MR25 |
| R459, R464 | 5322 116 54146 | 2,37 k | 1 | MR25 |
| R463 | 5322 116 50518 | 1,1 k | 1 | MR25 |
| R466, R467 | 5322 111 30365 | 51 | 5 | CR16 |
| R469 | 5322 116 50636 | 2,74 k | 1 | MR25 |
| R471 | 4822 111 30325 | 150 | 5 | CR16 |
| R472, R474 | 5322 116 54202 | 7,5 k | 1 | MR25 |
| R473 | 5322 116 50561 | 590 | 1 | MR25 |
| R476 | 4822 111 30325 | 150 | 5 | CR16 |
| R477 | 5322 116 50636 | 2,74 k | 1 | MR25 |
| R478 | 5322 116 54171 | 2,21 k | 1 | MR25 |

| *Item* | *Ordering number* | Ω | % | *Style* |
|---|---|---|---|---|
| R479, R481 | 5322 116 50967 | 2,1 k | 1 | MR25 |
| R482 | 5322 116 54171 | 2,21 k | 1 | MR25 |
| R483 | 4822 111 30269 | 1 k | 5 | CR16 |
| R484, R489 | 4822 111 30324 | 100 | 5 | CR16 |
| R488, R490, R492 | 4822 111 30269 | 1 k | 5 | CR16 |
| R493, R494 | 4822 111 30139 | 16 k | 5 | CR16 |
| R495 | – | – | 5 | CR16 |
| R500 | 4822 111 30303 | 8,2 k | 5 | CR16 |
| R501, R502 | 5322 111 44009 | 82 | 5 | CR16 |
| R506, R507 | 5322 111 44009 | 82 | 5 | CR16 |
| R509 | 5322 111 30354 | 12 | 5 | CR16 |
| R520 | 4822 111 30303 | 8,2 k | 5 | CR16 |
| R521, R522 | 5322 111 44009 | 82 | 5 | CR16 |
| R526, R527 | 5322 111 44009 | 82 | 5 | CR16 |
| R529 | 5322 111 30354 | 12 | 5 | CR16 |
| R543, R548 | 4822 111 30311 | 3,9 k | 5 | CR16 |
| R560 | 5322 116 50788 | 332 | 1 | MR25 |
| R566 | 5322 111 44156 | 510 | 5 | CR16 |
| R574 | 5322 111 30074 | 56 | 5 | CR16 |
| R576 | 4822 111 30273 | 10 k | 5 | CR16 |
| R604 | 5322 116 50978 | 825 | 1 | MR25 |
| R602, R606 | 5322 111 30074 | 56 | 5 | CR16 |
| R607 | 5322 116 54136 | 681 | 1 | MR25 |
| R608 | 5322 111 30401 | 47 | 5 | CR16 |
| R609 | 4822 111 30312 | 4,7 k | 5 | CR16 |
| R610 | 5322 111 30347 | 10 | 5 | CR16 |
| R612 | 4822 111 30312 | 4,7 k | 5 | CR16 |
| R613 | 5322 111 30401 | 47 | 5 | CR16 |
| R614 | 5322 116 54136 | 681 | 1 | MR25 |
| R615 | 5322 111 30347 | 10 | 5 | CR16 |
| R616 | 5322 116 50978 | 825 | 1 | MR25 |
| R617, R619 | 5322 111 30074 | 56 | 5 | CR16 |
| R623, R626 | 5322 116 54167 | 121 | 1 | MR25 |
| R629, R636 | 5322 116 50965 | 1,21 k | 1 | MR25 |
| R639, R641 | 4822 111 30327 | 220 | 5 | CR16 |
| R702 | 5322 111 30401 | 47 | 5 | CR16 |
| R704 | 4822 111 30267 | 1,5 k | 5 | CR16 |
| R706 | 5322 111 30399 | 33 | 5 | CR16 |
| R711 | 5322 111 44009 | 82 | 5 | CR16 |
| R716 | 5322 111 30401 | 47 | 5 | CR16 |
| R718 | 4822 111 30267 | 1,5 k | 5 | CR16 |
| R719 | 5322 111 30399 | 33 | 5 | CR16 |
| R724, R730 | 5322 111 44009 | 82 | 5 | CR16 |
| R739, R746 | 5322 111 44009 | 82 | 5 | CR16 |
| R749 | 5322 116 50972 | 270 | 2 | CR25 |
| R751, R756 | 5322 111 30399 | 33 | 5 | CR16 |
| R753 | 5322 116 54146 | 2,4 k | 2 | CR25 |
| R759 | 5322 116 50095 | 510 | 2 | CR25 |
| R761 | 5322 116 50973 | 2,7 k | 2 | CR25 |
| R764 | 5322 111 44009 | 82 | 5 | CR16 |
| R767 | 5322 111 30269 | 1 k | 5 | CR16 |
| R769 | 5322 111 44009 | 82 | 5 | CR16 |
| R771 | 5322 111 30273 | 10 k | 5 | CR16 |
| R778, R780 | 5322 111 44009 | 82 | 5 | CR16 |

| *Item* | *Ordering number* | Ω | | % | *Style* |
|---|---|---|---|---|---|
| R781 | 5322 111 30269 | 1 | k | 5 | CR16 |
| R784, R786 | 5322 111 30347 | 10 | | 5 | CR16 |
| R788 | 5322 111 30399 | 33 | | 5 | CR16 |
| R789 | 5322 116 54146 | 2,4 | k | 2 | CR25 |
| R791 | 5322 111 44009 | 82 | | 5 | CR16 |
| R813 | 4822 111 30311 | 3,9 | k | 5 | CR16 |
| R814 | 5322 111 30137 | 13 | k | 5 | CR16 |
| R816 | 5322 111 30399 | 33 | | 5 | CR16 |
| R821 | 5322 111 30278 | 27 | k | 5 | CR16 |
| R822 | 5322 111 30393 | 6,2 | k | 5 | CR16 |
| R825 | 5322 116 34009 | NTC resistor 4,7 kohm (25 $^{o}$C) | | | |
| R826 | 4822 111 30303 | 8,2 | k | 5 | CR16 |
| R828 | 5322 111 30399 | 33 | | 5 | CR16 |
| R830 | 4822 111 30311 | 3,9 | k | 5 | CR16 |
| R831 | 5322 111 30401 | 47 | | 5 | CR16 |
| R832, R833 | 5322 111 30399 | 33 | | 5 | CR16 |
| R835 | 5322 111 30137 | 13 | k | 5 | CR16 |
| R836 | 5322 111 30279 | 33 | k | 5 | CR16 |
| R851 | 5322 116 54201 | 30 | k | 0,1 | MR39C |
| R852 | 5322 116 50663 | 15 | k | 1/4 | MR39C |
| R853 | 5322 116 54202 | 7,5 | k | 1/4 | MR39C |
| R854 | 5322 116 50807 | 3,74 | k | 1/4 | MR39C |
| R856 | 5322 116 54202 | 7,5 | k | 1/4 | MR39C |
| R857 | 5322 116 50663 | 15 | k | 1/4 | MR39C |
| R858 | 5322 116 54203 | 75 | k | 1/4 | MR39C |
| R859 | 5322 116 50113 | 150 | k | 1/4 | MR39C |
| R861 | 5322 116 50811 | 300 | k | 0,1 | MR39C |
| R862 | 5322 116 50815 | 741 | k | 1/4 | MR58C |
| R871 | 5322 116 50814 | 732 | k | 1/4 | MR58C |
| R872 | 5322 116 54203 | 75 | k | 1/4 | MR39C |
| R873 | 5322 116 50113 | 150 | k | 1/4 | MR39C |
| R874 | 5322 116 50811 | 300 | k | 1/4 | MR39C |
| R876, R877 | 5322 116 50815 | 741 | k | 1/4 | MR58C |
| R878 | 5322 116 50807 | 3,74 | k | 1/4 | MR39C |
| R879 | 5322 116 54202 | 7,5 | k | 1/4 | MR39C |
| R881 | 5322 116 50663 | 15 | k | 1/4 | MR39C |
| R882 | 5322 116 54202 | 7,5 | k | 1/4 | MR39C |
| R883 | 5322 116 50663 | 15 | k | 1/4 | MR39C |
| R884 | 5322 116 54201 | 30 | k | 0,1 | MR39C |
| R902 | 5322 111 30399 | 33 | | 5 | CR16 |
| R904 | 5322 111 30401 | 47 | | 5 | CR16 |
| R907 | 4822 111 30267 | 1,5 | k | 5 | CR16 |
| R911 | 5322 111 44009 | 82 | | 5 | CR16 |
| R916 | 5322 111 30399 | 33 | | 5 | CR16 |
| R918 | 5322 111 30401 | 47 | | 5 | CR16 |
| R921 | 4822 111 30267 | 1,5 | k | 5 | CR16 |
| R924, R930 | 5322 111 44009 | 82 | | 5 | CR16 |
| R939, R944 | 5322 111 44009 | 82 | | 5 | CR16 |
| R948 | 5322 111 44009 | 82 | | 5 | CR16 |
| R951 | 5322 111 30269 | 1 | k | 5 | CR16 |
| R956 | 5322 111 30273 | 10 | k | 5 | CR16 |
| R958, R964 | 5322 111 44009 | 82 | | 5 | CR16 |
| R967 | 5322 111 30269 | 1 | k | 5 | CR16 |
| R968, R969 | 5322 111 30347 | 10 | | 5 | CR16 |

| *Item* | *Ordering number* | Ω | | % | *Style* |
|---|---|---|---|---|---|
| R972 | 5322 111 44009 | 82 | | 5 | CR16 |
| R978 | 4822 111 30324 | 100 | | 5 | CR16 |
| R981, R982, R983 | 5322 111 30269 | 1 | k | 5 | CR16 |
| R984 | 5322 111 30347 | 10 | | 5 | CR16 |
| R986 | 5322 111 30269 | 1 | k | 5 | CR16 |
| R989 | 5322 116 54146 | 2,4 | k | 2 | CR25 |
| R992, R998 | 5322 111 30399 | 33 | | 5 | CR16 |
| R993 | 5322 116 50482 | 33 | k | 2 | CR25 |
| R994 | 5322 116 50973 | 2,7 | k | 2 | CR25 |
| R996 | 5322 116 54224 | 620 | | 2 | CR25 |
| R997 | 5322 116 54011 | 5,6 | k | 2 | CR25 |
| R999 | 5322 116 51056 | 11 | k | 2 | CR25 |
| R1001 | 5322 116 50972 | 270 | | 2 | CR25 |
| R1003 | 5322 116 50664 | 2 | k | 2 | CR25 |
| R1004 | 5322 111 44009 | 82 | | 5 | CR16 |
| R1005, R1006 | 4822 111 30311 | 3,9 | k | 5 | CR16 |
| R1007 | 5322 111 30399 | 33 | | 5 | CR16 |
| R1008 | 5322 116 50748 | 10 | k | 2 | CR25 |
| R1010, R1012 | 5322 111 30137 | 13 | k | 5 | CR16 |
| R1021 | 5322 111 30269 | 1 | k | 5 | CR16 |
| R1028, R1031 | 5322 111 30399 | 33 | | 5 | CR16 |
| R1042 | 4822 111 30331 | 470 | | 5 | CR16 |
| R1043 | 5322 111 44009 | 82 | | 5 | CR16 |
| R1044 | 5322 111 44011 | 1,8 | k | 5 | CR16 |
| R1051 | 5322 111 30278 | 27 | k | 5 | CR16 |
| R1053 | 5322 111 30393 | 6,2 | k | 5 | CR16 |
| R1054 | 4822 111 30303 | 8,2 | k | 5 | CR16 |
| R1056 | 5322 116 34009 | NTC resistor 4,7 kohm (25 °C) | | | |
| R1058 | 5322 111 30399 | 33 | | 5 | CR16 |
| R1061 | 5322 111 30401 | 47 | | 5 | CR16 |
| R1062 | 5322 111 30399 | 33 | | 5 | CR16 |
| R1063 | 4822 111 30323 | 270 | | 5 | CR16 |
| R1066 | 5322 111 30279 | 33 | k | 5 | CR16 |
| R1071 | 5322 111 30399 | 33 | | 5 | CR16 |
| R1074 | 5322 111 30069 | 39 | | 5 | CR16 |
| R1076 | 5322 111 30399 | 33 | | 5 | CR16 |
| R1078 | 5322 111 44009 | 82 | | 5 | CR16 |
| R1079 | 4822 111 30264 | 2,7 | k | 5 | CR16 |
| R1080 | 4822 111 30303 | 8,2 | k | 5 | CR16 |
| R1081 | 4822 111 30312 | 4,7 | k | 5 | CR16 |
| R1083 | 5322 111 44009 | 82 | | 5 | CR16 |
| R1084 | 5322 111 30269 | 1 | k | 5 | CR16 |
| R1085 | 5322 111 30329 | 390 | | 5 | CR16 |
| R1087 | 5322 111 44009 | 82 | | 5 | CR16 |
| R1091 | 5322 111 30296 | 100 | k | 5 | CR16 |
| R1095 | 5322 111 30289 | 56 | k | 5 | CR16 |
| R1098 | 4822 111 30312 | 4,7 | k | 5 | CR16 |
| R1103 | 5322 111 44009 | 82 | | 5 | CR16 |
| R1108 | 5322 111 30279 | 33 | k | 5 | CR16 |
| R1124 | — | — | | 5 | CR16 |
| R1128 | 5322 111 30268 | 1,2 | k | 5 | CR16 |
| R1129 | 5322 111 44009 | 82 | | 5 | CR16 |
| R1150 | 5322 111 30074 | 56 | | 5 | CR16 |
| R1153, R1155 | 5322 116 50175 | 649 | | 1 | MR25 |

| *Item* | *Ordering number* | Ω | % | *Style* |
|---|---|---|---|---|
| R1157, R1158 | 4822 111 30311 | 3,9 k | 5 | CR16 |
| R1161 | 5322 116 54171 | 2,21 k | 1 | MR25 |
| R1162 | 5322 111 30074 | 56 | 5 | CR16 |
| R1163 | 5322 116 54171 | 2,21 k | 1 | MR25 |
| R1164 | 5322 116 50728 | 1,87 k | 1 | MR25 |
| R1165, R1170 | 4822 116 40007 | PTC resistor 50 ± 15 ohm (25 °C) | | |
| R1169 | 5322 111 30074 | 56 | 1 | CR16 |
| R1171, R1172 | 5322 116 54171 | 2,21 k | 1 | MR25 |
| R1173 | 5322 116 50728 | 1,87 k | 1 | MR25 |
| R1176 | 5322 111 44009 | 82 | 5 | CR16 |
| R1179, R1180 | 5322 116 54204 | 22,6 k | 1 | MR39C |
| R1181 | 5322 116 50558 | 18,7 k | 1 | MR25 |
| R1182, R1183 | 5322 111 44009 | 82 | 5 | CR16 |
| R1186 | 5322 116 50791 | 3,83 k | 1 | MR25 |
| R1187, R1188 | 5322 116 54204 | 22,6 k | 1 | MR39C |
| R1189, R1190 | 5322 111 44009 | 82 | 5 | CR16 |
| R1192 | 5322 111 44009 | 82 | 5 | CR16 |
| R1201 | 5322 113 60022 | 0,47 | 10 | 2W; WW |
| R1207 | 5322 116 50675 | 2,26 k | 1 | MR25 |
| R1209 | 5322 116 50636 | 2,74 k | 1 | MR25 |
| R1215 | 4822 111 30339 | 1 | 5 | CR37 |
| R1217 | 5322 116 50515 | 1,78 k | 1 | MR25 |
| R1218 | 5322 116 50791 | 3,83 k | 1 | MR25 |
| R1234 | 4822 113 60028 | 2,2 | 10 | 2W; WW |
| R1241 | 5322 116 50675 | 2,26 k | 1 | MR25 |
| R1243 | 5322 116 50636 | 2,74 k | 1 | MR25 |
| R1246, R1247 | 5322 116 50515 | 1,78 k | 1 | MR25 |
| R1250 | 5322 111 50345 | 8,2 M | 5 | 1W |
| R1253 | 5322 115 90082 | 65 | ± 1 ohm | Cu WW |
| R1254 | 5322 116 50544 | 866 | 1/4 | MR39E |
| R1259 | 5322 116 50806 | 3,01 k | 1/4 | MR39E |
| R1261 | 5322 116 54205 | 7,68 k | 1/4 | MR39E |
| R1264 | 5322 116 34011 | NTC resistor 33 ohm (25 °C) | | |
| R1265 | 5322 116 50472 | 1,87 k | 1/4 | MR39E |
| R1266 | 5322 116 50804 | 1,21 k | 1/4 | MR39E |
| R1267 | 5322 116 50268 | 100 | 1/4 | MR39E |
| R1268 | 5322 116 50806 | 3,01 k | 1/4 | MR39E |
| R1269 | 5322 111 30399 | 33 | 5 | CR16 |
| R1271 | 5322 116 54206 | 43,8 k | 1/4 | MR39E |
| R1272 | 5322 111 30326 | 180 | 5 | CR16 |
| R1275 | 5322 110 60104 | 750 | 5 | CR16 |
| R1311 | 5322 116 50818 | 44,2 | 1 | MR25 |
| R1312 | 5322 116 50788 | 332 | 1 | MR25 |
| R1317 | 4822 111 30324 | 100 | 5 | CR16 |
| R1329 | 5322 116 50817 | 51,1 | 1 | MR81D |
| R1336 | 4822 111 30327 | 220 | 5 | CR16 |
| R1401 | 5322 111 30277 | 22 k | 5 | CR16 |
| R1402 | 5322 111 30269 | 1 k | 5 | CR16 |
| R1403 | 5322 116 54003 | 22,1 k | 1 | MR25 |
| R1404, R1407 | 5322 111 30296 | 100 k | 5 | CR16 |
| R1409 | 4822 111 30267 | 1,5 k | 5 | CR16 |
| R1411 | 4822 111 30309 | 560 | 5 | CR16 |
| R1413 | 4822 111 30265 | 2,2 k | 5 | CR16 |
| R1414, R1416 | 5322 111 30296 | 100 k | 5 | CR16 |

| Item | Ordering number | Ω | | % | Style |
|---|---|---|---|---|---|
| R1418 | 4822 111 30263 | 3,3 | k | 5 | CR16 |
| R1422 | 5322 111 30296 | 100 | k | 5 | CR16 |
| R1423 | 5322 111 30277 | 22 | k | 5 | CR16 |
| R1424 | 5322 111 30269 | 1 | k | 5 | CR16 |
| R1426 | 5322 116 54003 | 22 | k | 1 | MR25 |
| R1427 | 5322 111 30296 | 100 | k | 5 | CR16 |
| R1431 | 4822 111 30309 | 560 | | 5 | CR16 |
| R1433 | 5322 111 30277 | 22 | k | 5 | CR16 |
| R1434 | 4822 111 30267 | 1,5 | k | 5 | CR16 |
| R1436 | 4822 111 30265 | 2,2 | k | 5 | CR16 |
| R1437, R1438 | 5322 111 30296 | 100 | k | 5 | CR16 |
| R1441 | 4822 111 30263 | 3,3 | k | 5 | CR16 |
| R1443, R1446 | 5322 116 54011 | 5,62 | k | 1 | MR25 |
| R1448 | 5322 116 54171 | 2,21 | k | 1 | MR25 |
| R1449 | 4822 111 30303 | 8,2 | k | 5 | CR16 |
| R1451, R1452 | 5322 116 50474 | 42,2 | k | 1 | MR25 |
| R1453 | 4822 111 30303 | 8,2 | k | 5 | CR16 |
| R1454 | 5322 116 54171 | 2,21 | k | 1 | MR25 |
| R1601 | 4822 111 30325 | 150 | | 5 | CR16 |
| R1603 | 5322 116 54182 | 261 | | 1 | MR25 |
| R1604 | 5322 111 30281 | 39 | k | 5 | CR16 |
| R1606, R1611, R1614 | 5322 116 54182 | 261 | | 1 | MR25 |
| R1616 | 4822 111 30325 | 150 | | 5 | CR16 |
| R1621 | 4822 111 30325 | 150 | | 5 | CR16 |
| R1622 | 5322 111 30273 | 10 | k | 5 | CR16 |

**PM 3250X**

| Item | Ordering number | Ω | | % | Style |
|---|---|---|---|---|---|
| R1124 | 5322 116 50554 | 750 | | 1 | MR25 |
| R2102, R2103 | 5322 111 30296 | 100 | k | 5 | CR16 |
| R2104 | 5322 111 30304 | 150 | k | 5 | CR16 |
| R2107 | 5322 111 30275 | 15 | k | 5 | CR16 |
| R2108 | 5322 111 30296 | 100 | k | 5 | CR16 |
| R2109 | 5322 111 30273 | 10 | k | 5 | CR16 |
| R2111 | 5322 111 30277 | 22 | k | 5 | CR16 |
| R2112 | 5322 111 44144 | 11 | k | 5 | CR16 |
| R2117 | 5322 111 30376 | 100 | M | 5 | 0,125 W Allen Bradley |
| R2118 | 5322 111 30305 | 36 | k | 5 | CR16 |
| R2119 | 4822 111 30312 | 4,7 | k | 5 | CR16 |
| R2121, R2122 | 5322 111 30273 | 10 | k | 5 | CR16 |
| R2123 | 5322 111 30304 | 150 | k | 5 | CR16 |
| R2124 | 4822 111 30333 | 1 | M | 5 | CR16 |
| R2126 | 5322 111 30281 | 39 | k | 5 | CR16 |
| R2127 | 5322 111 30273 | 10 | k | 5 | CR16 |
| R2128 | 5322 111 30378 | 200 | | 5 | CR16 |
| R2129 | 5322 111 30296 | 100 | k | 5 | CR16 |
| R2131 | 4822 111 30263 | 3,3 | k | 5 | CR16 |
| R2132 | 5322 111 30296 | 100 | k | 5 | CR16 |
| R2133 | 4822 111 30328 | 330 | | 5 | CR16 |
| R2134 | 4822 111 30333 | 1 | M | 10 | CR16 |
| R2136 | 5322 111 34091 | 30 | k | 5 | CR16 |
| R2137 | 5322 111 30124 | 4,3 | k | 5 | CR16 |
| R2138 | 4822 111 30267 | 1,5 | k | 5 | CR16 |

| *Item* | *Ordering number* | Ω | | % | *Style* |
|---|---|---|---|---|---|
| R2139 | 5322 111 30265 | 2,2 | k | 5 | CR16 |
| R2141 | 5322 111 30296 | 100 | k | 5 | CR16 |
| R2142 | 4822 111 30313 | 5,6 | k | 5 | CR16 |
| R2143 | 5322 111 30269 | 1 | k | 5 | CR16 |
| R2144 | 5322 111 30277 | 22 | k | 5 | CR16 |
| R2146 | 5322 111 44143 | 51 | k | 5 | CR16 |
| R2147 | 5322 116 50458 | 7,87 | k | 1 | MR25 |
| R2148 | 5322 116 54047 | 787 | | 1 | MR25 |
| R2151 | 5322 111 44009 | 82 | | 5 | CR16 |
| R2153 | 5322 116 50414 | 2,87 | k | 1 | MR25 |
| R2154 | 5322 116 50908 | 23,7 | k | 1 | MR25 |
| R2156 | 5322 116 50579 | 3,16 | k | 1 | MR25 |
| R2157 | 5322 111 30293 | 180 | k | 5 | CR16 |
| R2158 | 5322 111 30306 | 75 | k | 5 | CR16 |
| R2159 | 5322 111 30288 | 47 | k | 5 | CR16 |
| R2161 | 5322 111 30289 | 56 | k | 5 | CR16 |
| R2162 | 5322 111 30275 | 15 | k | 5 | CR16 |
| R2163 | 5322 111 30307 | 91 | k | 5 | CR16 |
| R2164 | 4822 111 30333 | 1 | M | 10 | CR16 |
| R2167, R2168 | 5322 111 30296 | 100 | k | 5 | CR16 |
| R2169 | 5322 111 30273 | 10 | k | 5 | CR16 |
| R2171 | 5322 111 30277 | 22 | k | 5 | CR16 |
| R2172 | 4822 111 30263 | 3,3 | k | 5 | CR16 |
| R2173 | 5322 111 30258 | 390 | k | 10 | CR16 |
| R2176 | 4822 111 30324 | 100 | | 5 | CR16 |
| R2178 | 5322 111 44144 | 11 | k | 5 | CR16 |

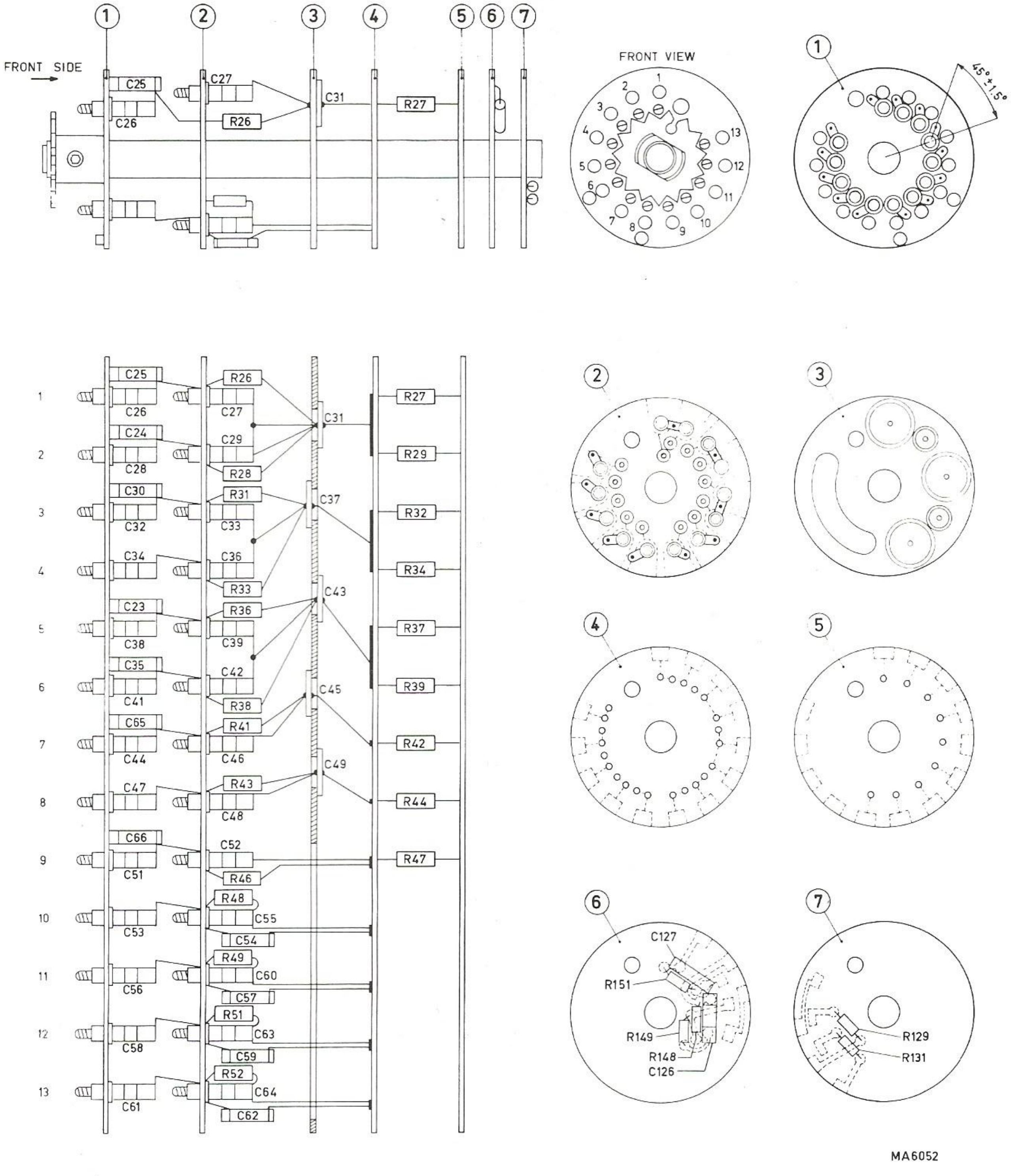



*Fig. XIV-1a. Component location*

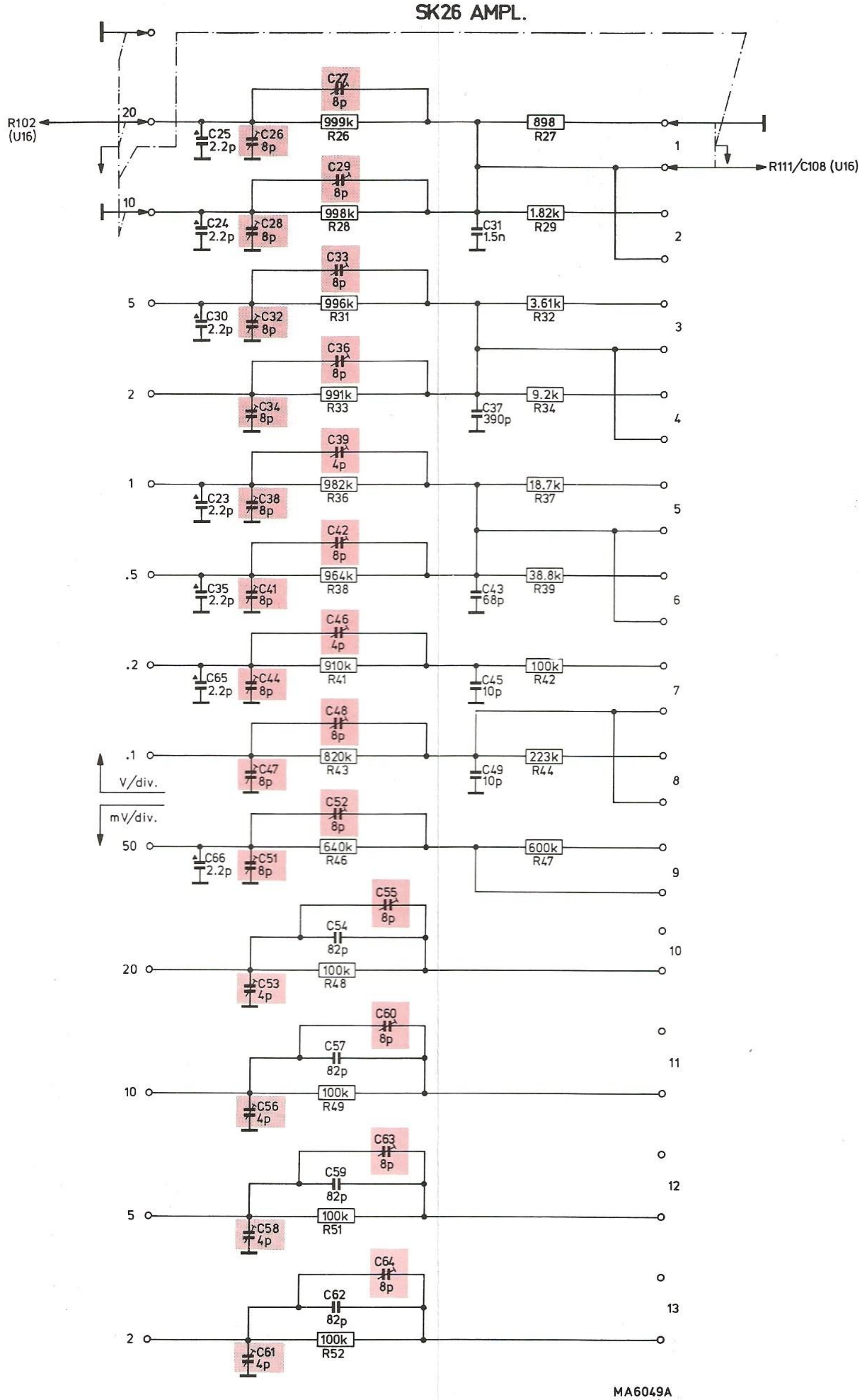



*Fig. XIV-1. Circuit diagram*

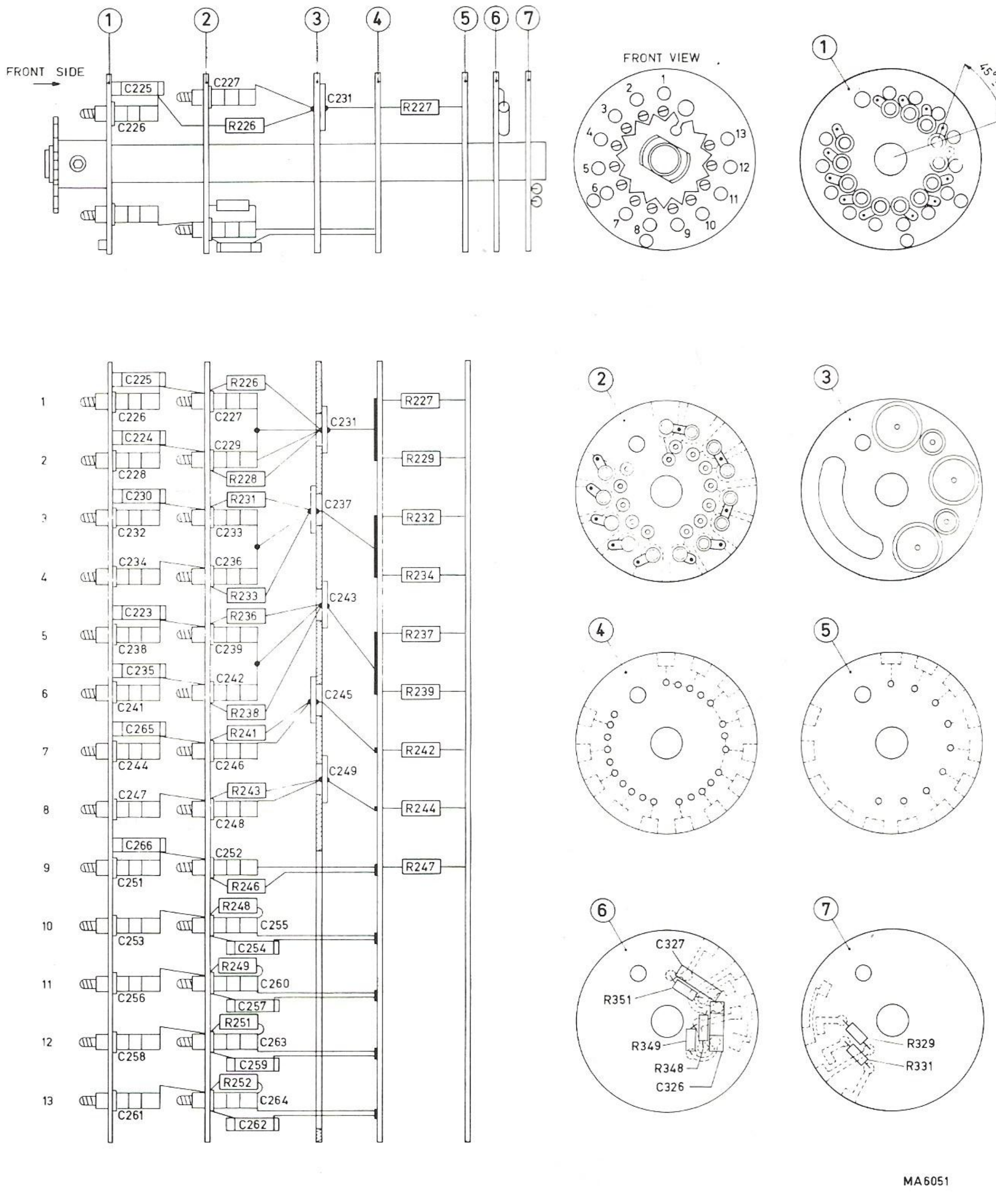



*Fig. XIV-2a. Component location*

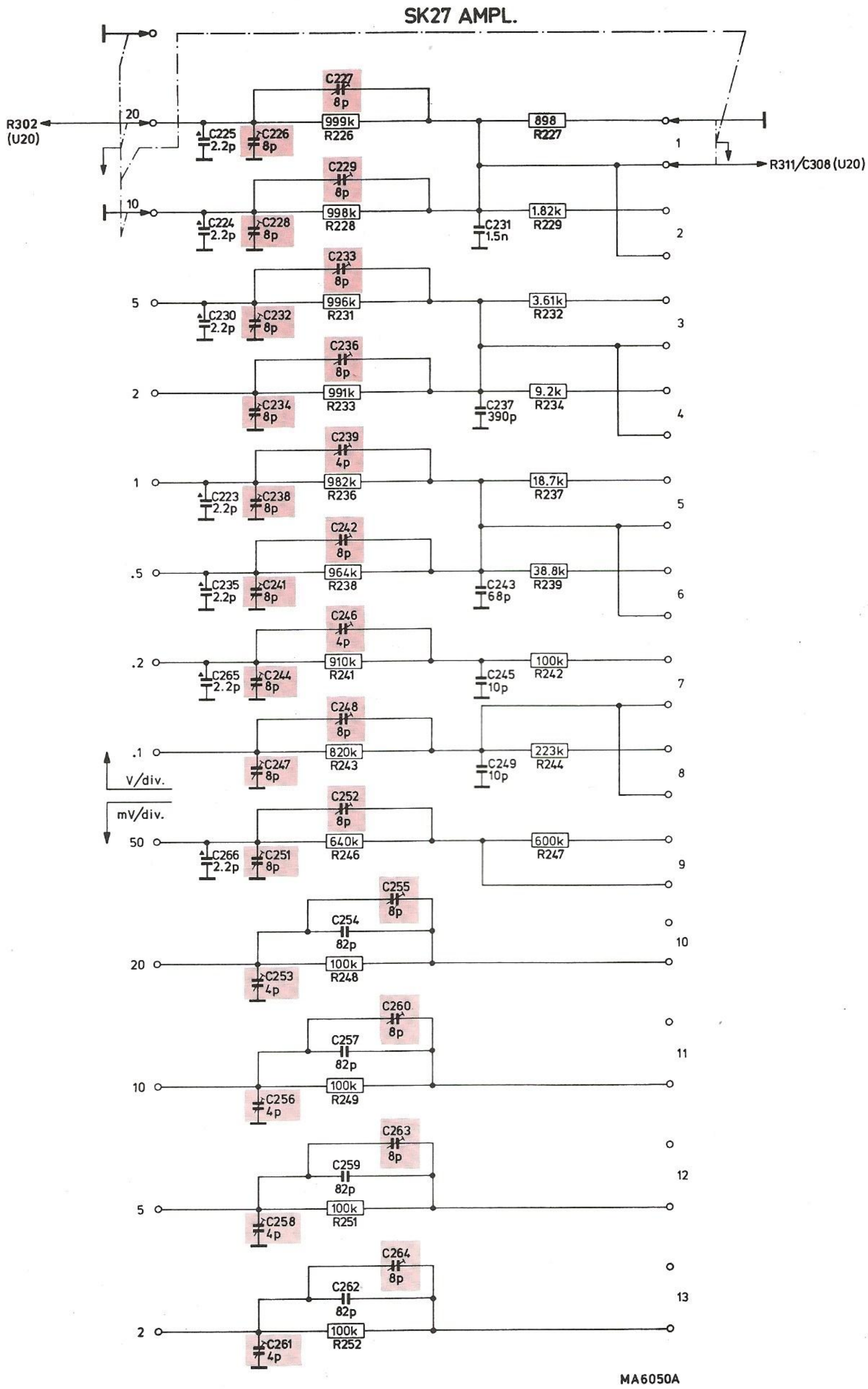



*Fig. XIV-2. Circuit diagram*

## ATTENUATOR B UNIT 22

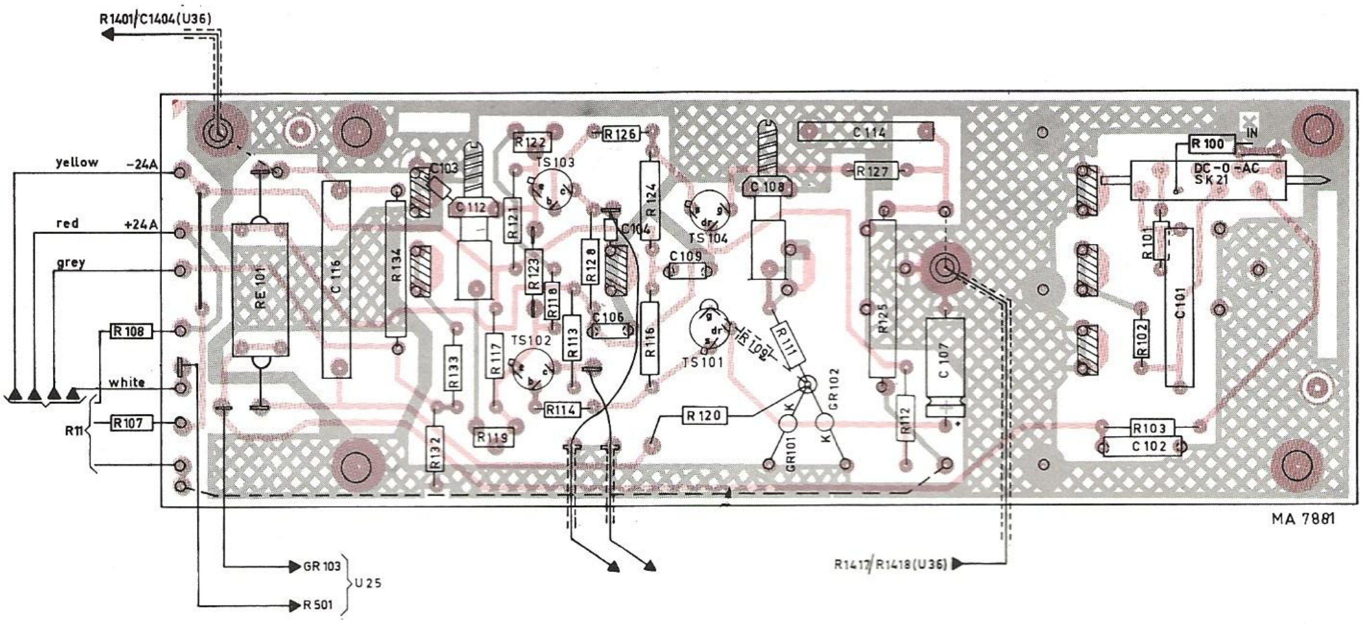



*Fig. XIV-3a. Board 1*

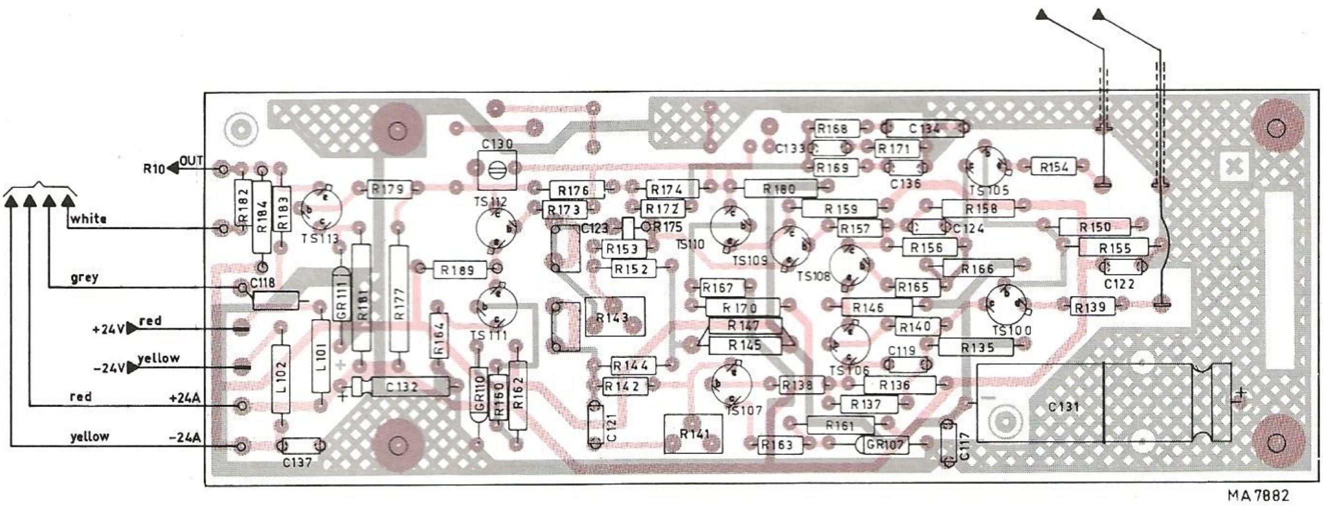
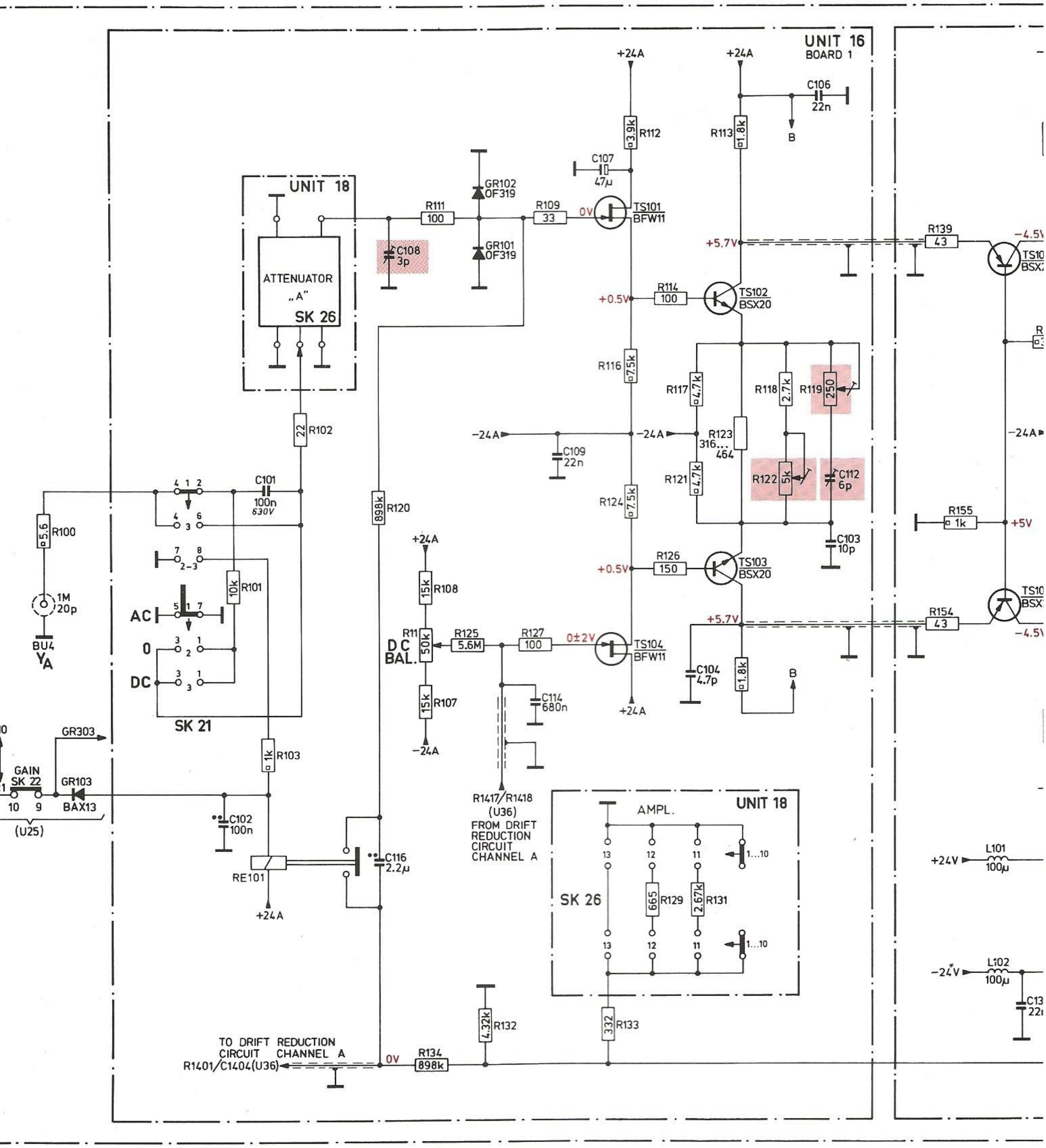



*Fig. XIV-3b. Board 2*


**Component location**



UNIT 16
BOARD 1
UNIT 18
ATTENUATOR „A"
SK 26
R111 100
R109 33
TS101 BFW11
GR102 OF319
GR101 OF319
C108 3p
C107 47μ
R112 3.9k
R113 1.8k
C106 22n
+24A
+5.7V
R139 43
-4.5V
R114 100
TS102 BSX20
+0.5V
R116 7.5k
R117 4.7k
R118 2.7k
R119 250
R123 316...464
-24A
C109 22n
R121 4.7k
R122 5k
C112 6p
R124 7.5k
C103 10p
R155 1k
+5V
R126 150
TS103 BSX20
R154 43
R102 22
C101 100n 630V
R100 5.6
1M 20p
BU4 YA
AC
0
DC
SK 21
R101 10k
R120 898k
R108 15k
R11 50k
DC BAL.
R125 5.6M
R127 100
0±2V
TS104 BFW11
C104 4.7p
C114 680n
R107 15k
GR303
GAIN SK 22
GR103 BAX13
(U25)
R103 1k
C102 100n
RE101
C116 2.2μ
R1417/R1418 (U36) FROM DRIFT REDUCTION CIRCUIT CHANNEL A
AMPL.
SK 26
R129 665
R131 2.67k
1...10
+24V
L101 100μ
-24V
L102 100μ
R132 4.32k
R133 332
TO DRIFT REDUCTION CIRCUIT CHANNEL A R1401/C1404(U36)
0V
R134 898k

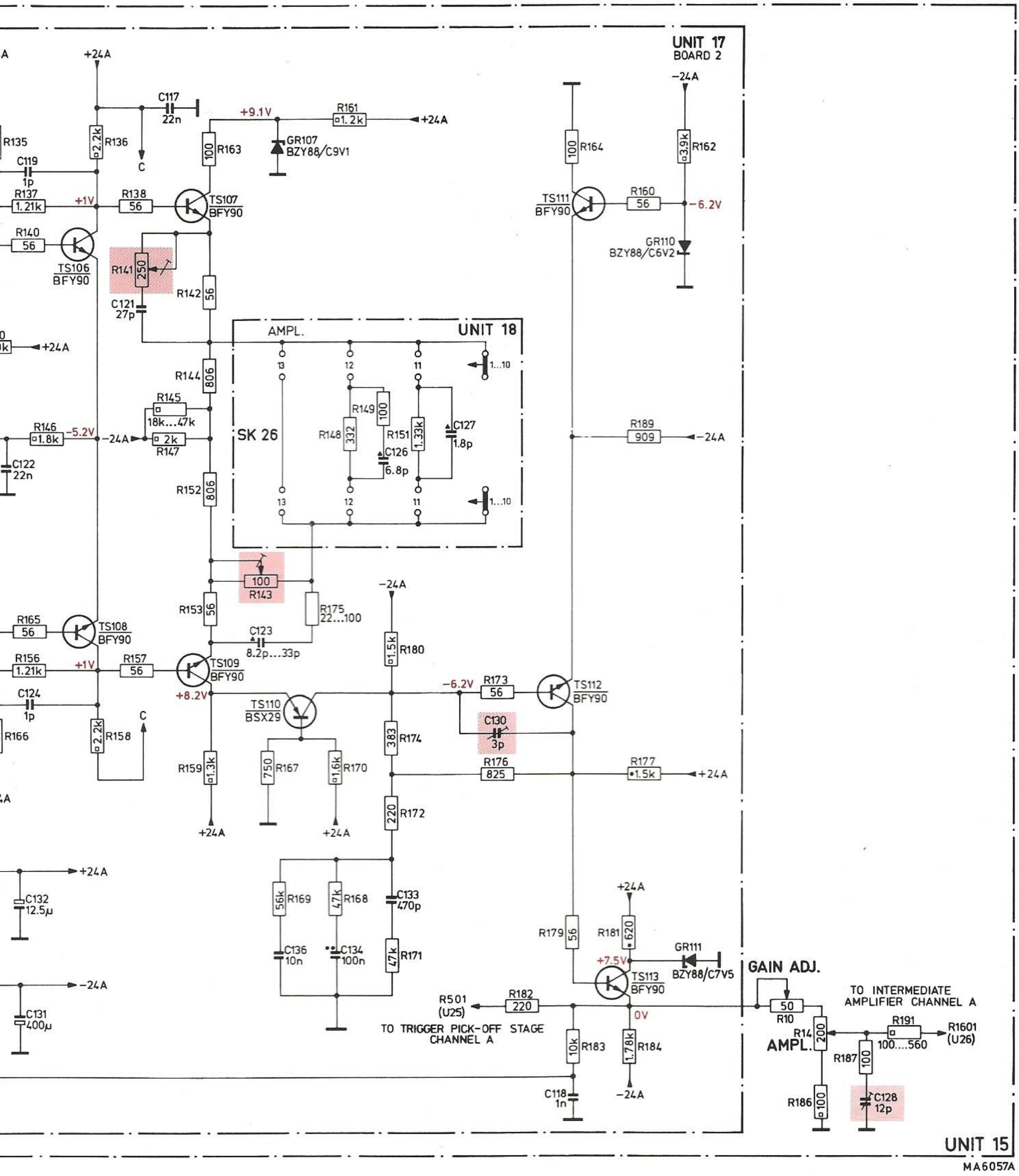



*Fig. XIV-3. Circuit diagram*

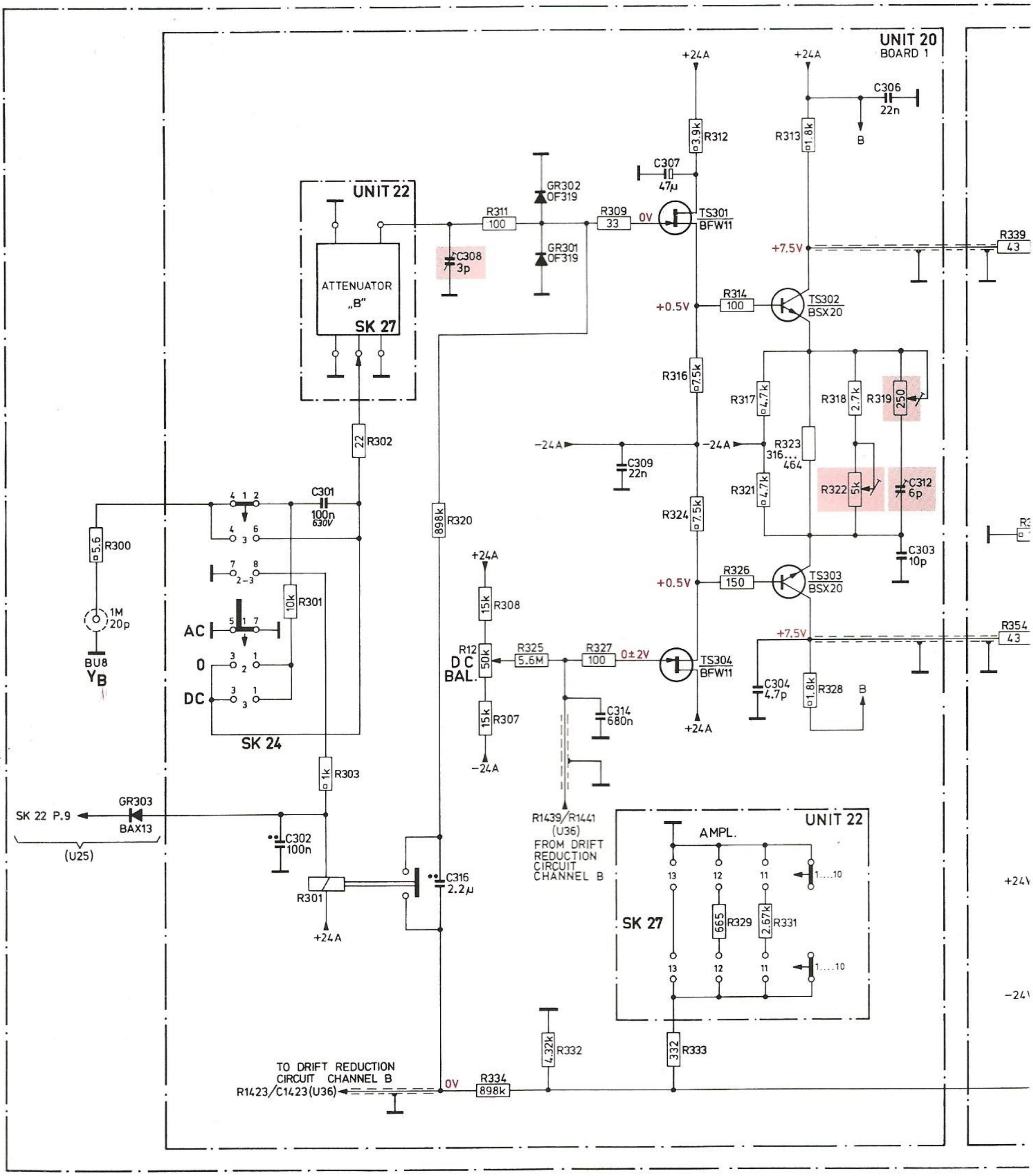
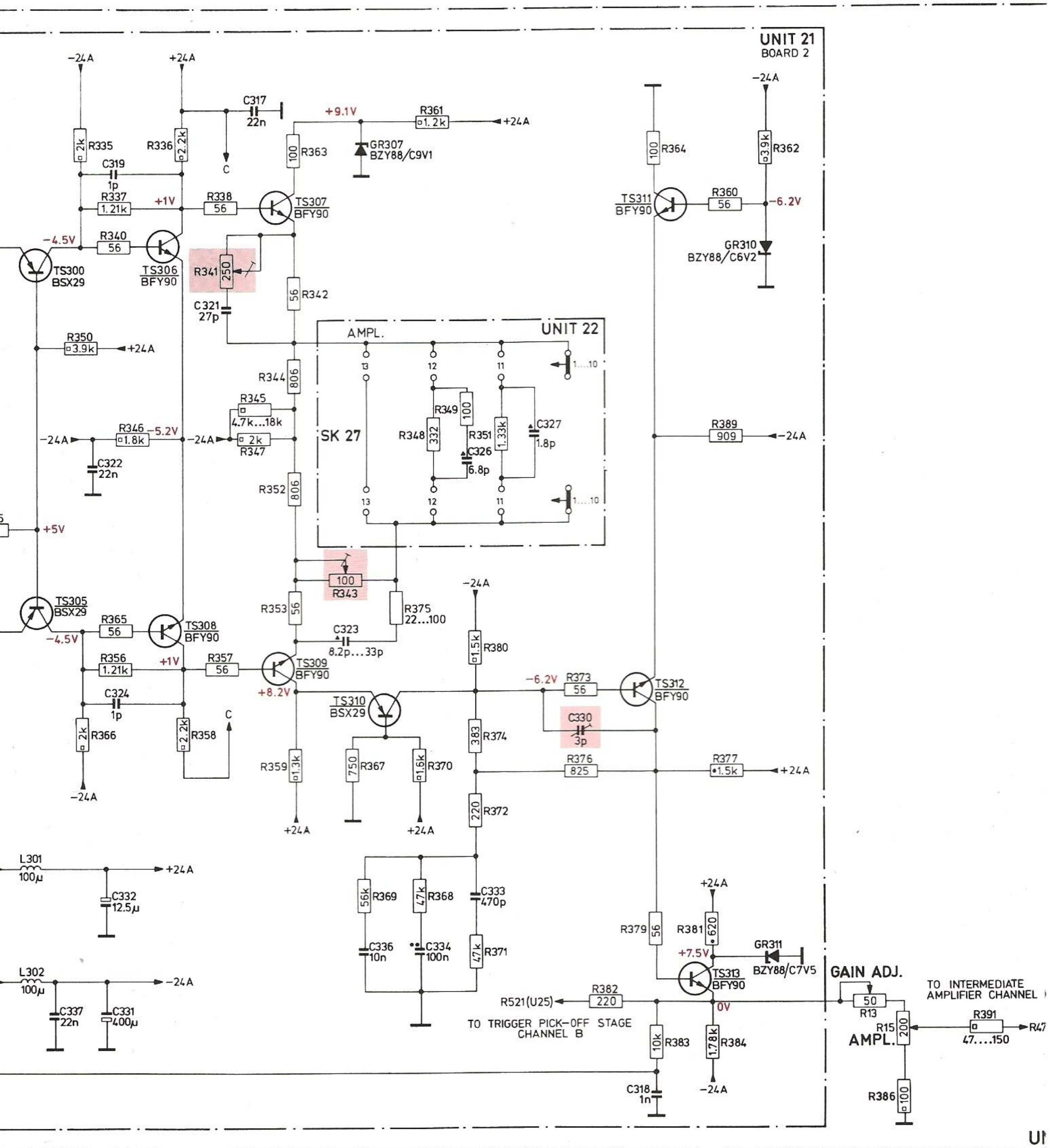



*Fig. XIV-4. Circuit diagram*



UNIT 21
BOARD 2
UNIT 22
AMPL.
SK 27
GAIN ADJ.
TO INTERMEDIATE AMPLIFIER CHANNEL
TO TRIGGER PICK-OFF STAGE CHANNEL B
R521(U25)
AMPL.
TS300 BSX29
TS305 BSX29
TS306 BFY90
TS307 BFY90
TS308 BFY90
TS309 BFY90
TS310 BSX29
TS311 BFY90
TS312 BFY90
TS313 BFY90
GR307 BZY88/C9V1
GR310 BZY88/C6V2
GR311 BZY88/C7V5
R341 250
R343 100
C330 3p
R375 22...100
C323 8.2p...33p
R345 4.7k...18k
R391 47....150

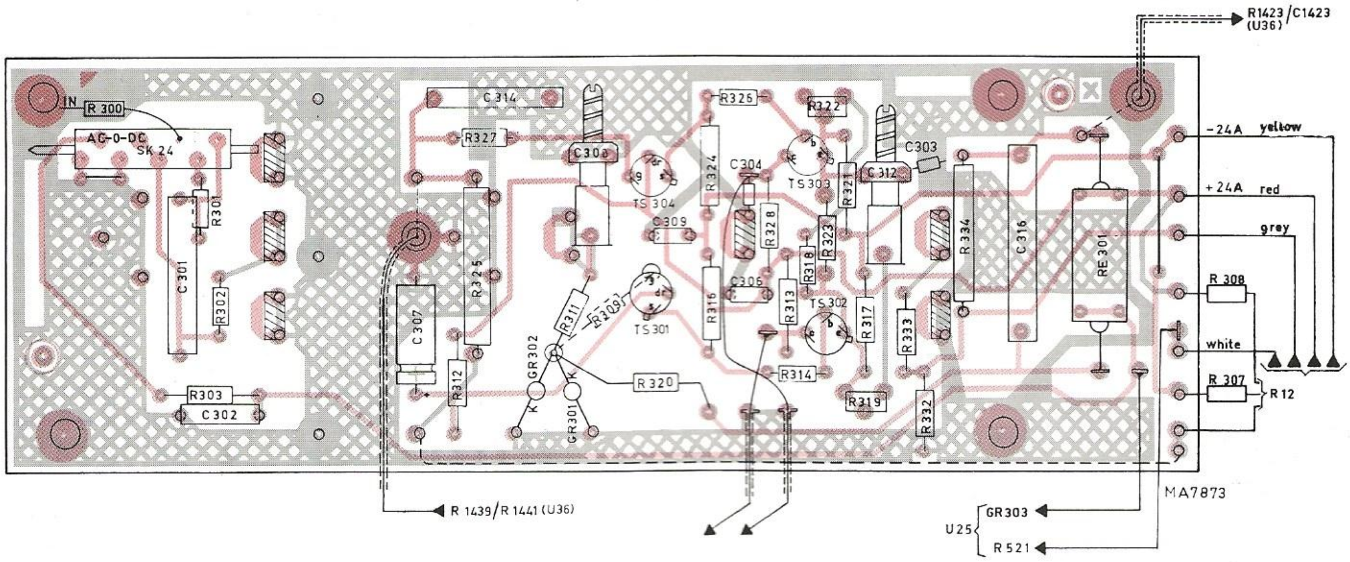



*Fig. XIV-4a. Board 1*

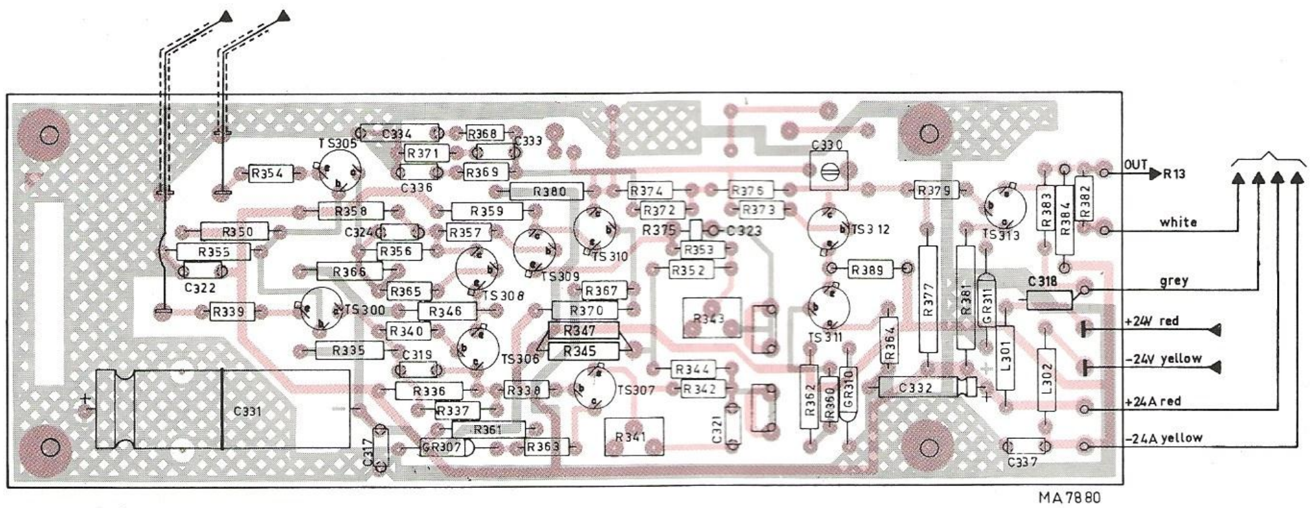
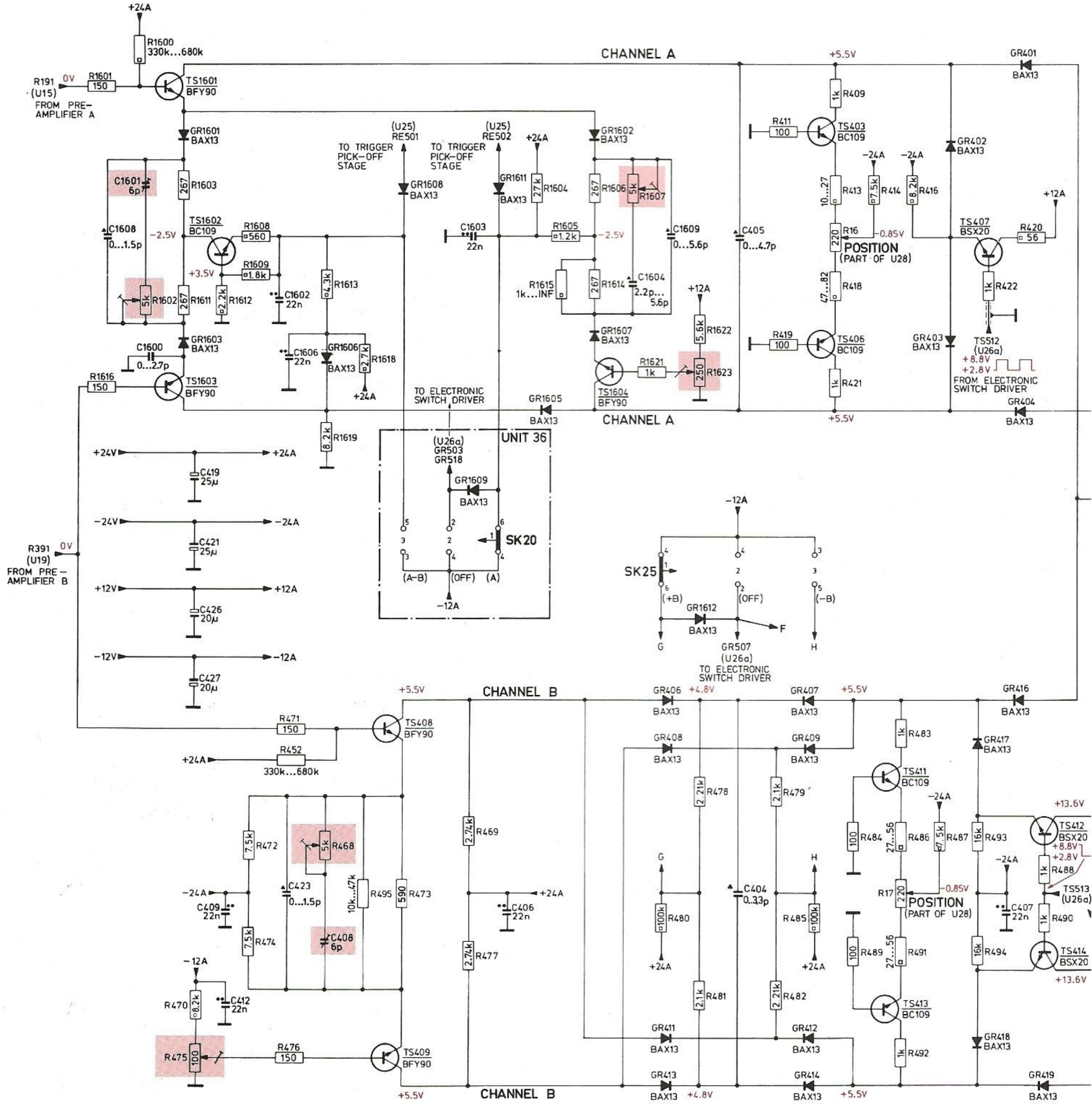



*Fig. XIV-4b. Board 2*



CHANNEL A
CHANNEL B
+24A
R1600
330k...680k
R191
(U15)
FROM PRE-AMPLIFIER A
0V
R1601
150
TS1601
BFY90
GR1601
BAX13
C1601
6p
R1603
267
C1608
0...1.5p
-2.5V
TS1602
BC109
+3.5V
R1608
560
R1609
1.8k
R1612
2.2k
C1602
22n
R1602
5k
R1611
267
GR1603
BAX13
C1600
0...2.7p
R1616
150
TS1603
BFY90
(U25)
RE501
TO TRIGGER PICK-OFF STAGE
GR1608
BAX13
(U25)
RE502
GR1611
BAX13
R1604
27k
C1603
22n
R1605
1.2k
R1613
4.3k
C1606
22n
GR1606
BAX13
R1618
2.7k
R1619
8.2k
GR1602
BAX13
R1606
267
R1607
5k
C1609
0...5.6p
R1615
1k...INF
R1614
267
C1604
2.2p...5.6p
GR1607
BAX13
+12A
R1622
5.6k
R1621
1k
R1623
250
TS1604
BFY90
TO ELECTRONIC SWITCH DRIVER
GR1605
BAX13
UNIT 36
(U26a)
GR503
GR518
GR1609
BAX13
SK20
(A-B)
(OFF)
(A)
-12A
+24V
C419
25μ
-24V
-24A
C421
25μ
+12V
C426
20μ
-12V
C427
20μ
R391
(U19)
FROM PRE-AMPLIFIER B
+5.5V
R409
1k
R411
100
TS403
BC109
R413
10...27
R414
7.5k
R416
8.2k
R16
220
POSITION
(PART OF U28)
-0.85V
R418
47...82
R419
100
TS406
BC109
R421
1k
C405
0...4.7p
GR401
BAX13
GR402
BAX13
TS407
BSX20
R420
56
R422
1k
GR403
BAX13
TS512
(U26a)
+8.8V
+2.8V
FROM ELECTRONIC SWITCH DRIVER
GR404
BAX13
SK25
(+B)
(OFF)
(-B)
GR1612
BAX13
F
G
H
GR507
(U26a)
TO ELECTRONIC SWITCH DRIVER
R471
150
TS408
BFY90
R452
330k...680k
R472
7.5k
R468
5k
C423
0...1.5p
R495
10k...47k
R473
590
C409
22n
R474
7.5k
C408
6p
R470
8.2k
C412
22n
R475
100
R476
150
TS409
BFY90
R469
2.74k
R477
2.74k
C406
22n
GR406
BAX13
+4.8V
GR407
BAX13
GR408
BAX13
GR409
BAX13
R478
2.21k
R479
2.1k
C404
0...33p
R480
100k
R485
100k
R481
2.1k
R482
2.21k
GR411
BAX13
GR412
BAX13
GR413
BAX13
GR414
BAX13
R483
1k
TS411
BC109
R484
100
R486
27...56
R487
7.5k
R17
220
POSITION
(PART OF U28)
R489
100
R491
27...56
TS413
BC109
R492
1k
GR416
BAX13
GR417
BAX13
R493
16k
+13.6V
TS412
BSX20
R488
1k
TS513
(U26a)
C407
22n
R490
1k
R494
16k
TS414
BSX20
GR418
BAX13
GR419
BAX13

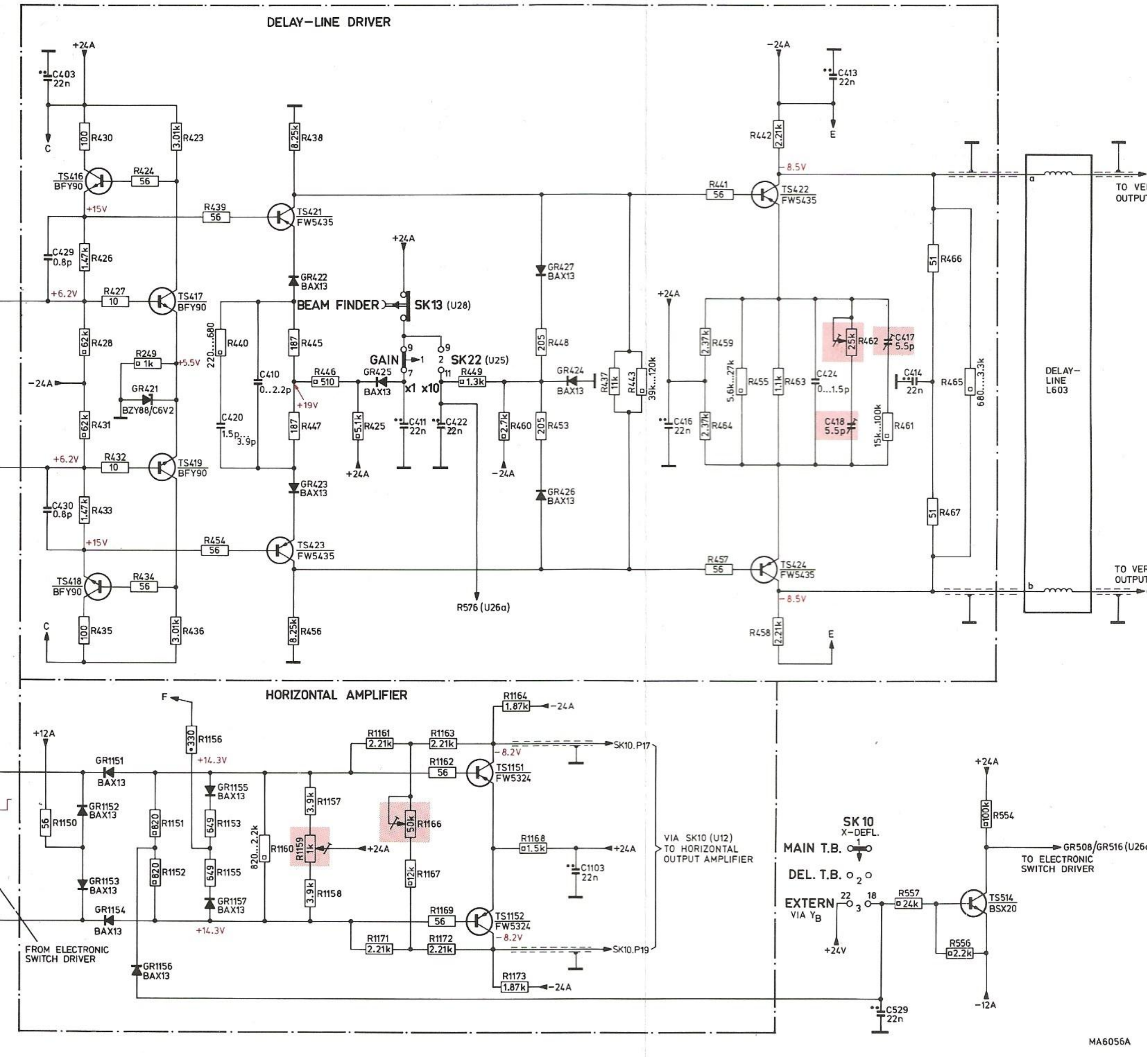



*Fig. XIV-5. Circuit d*

INTERMEDIATE AMPLIFIER UNI

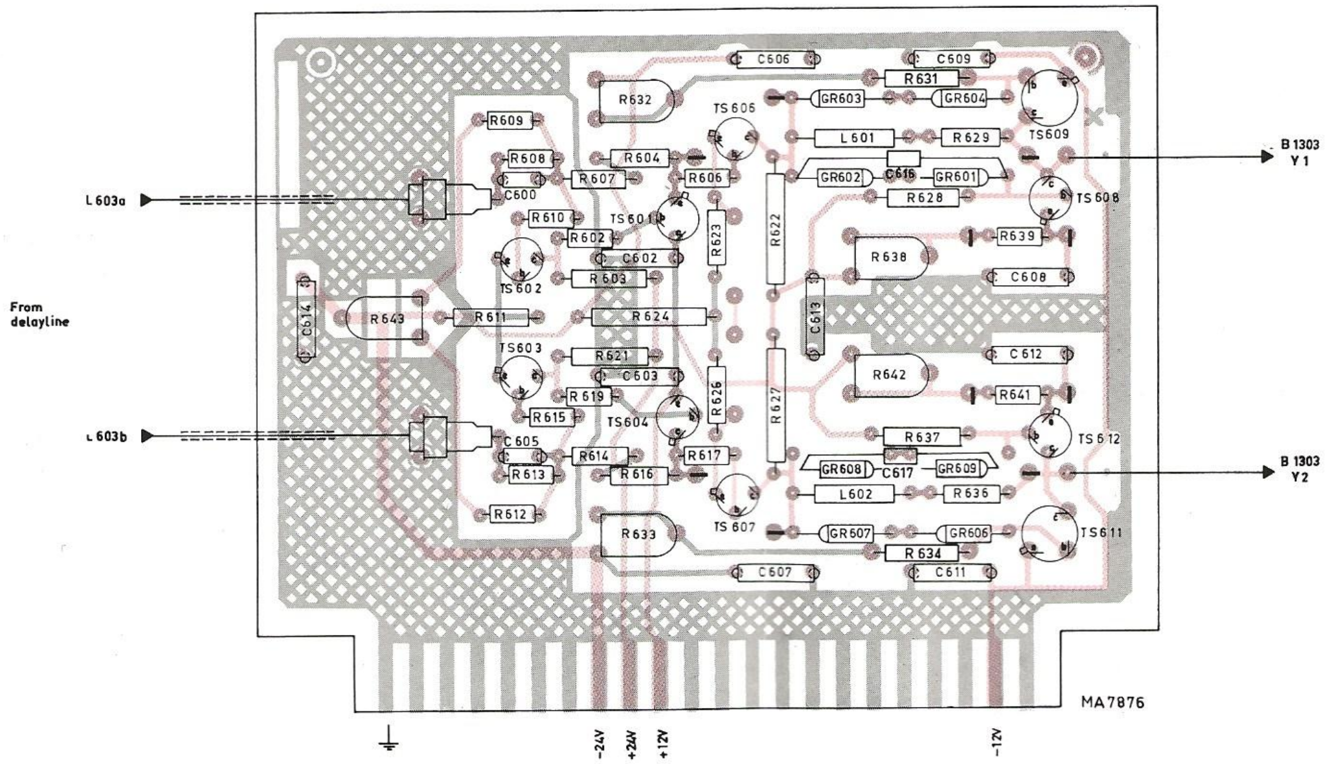



*Fig. XIV-6a. Component location*

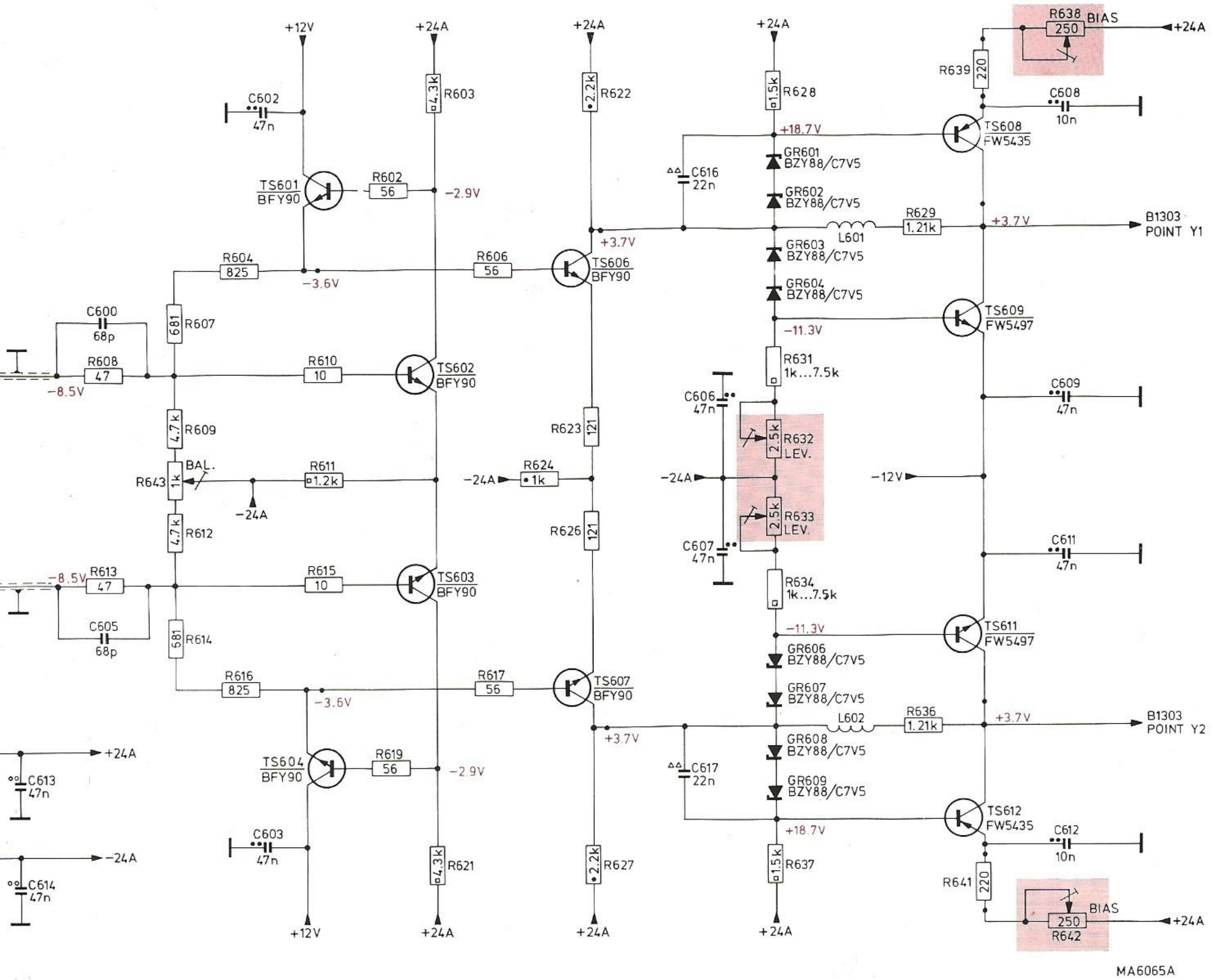
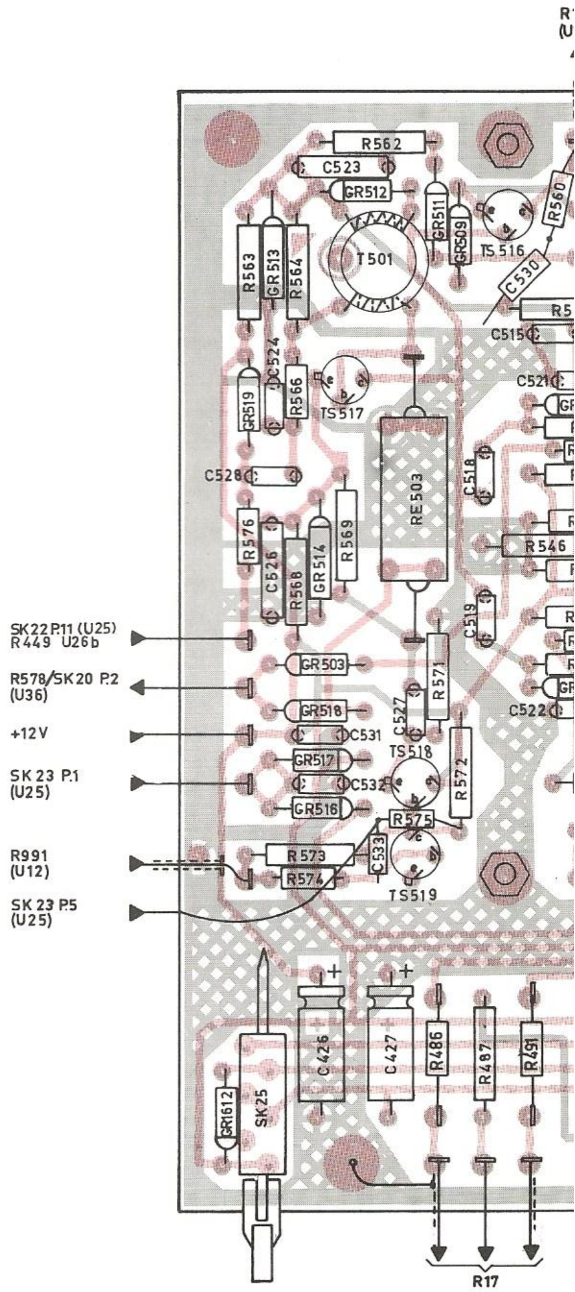



*Fig. XIV-6. Circuit diagram*


SK22 P.11 (U25)
R449 U26b
R578/SK20 P.2
(U36)
+12V
SK 23 P.1
(U25)
R991
(U12)
SK 23 P.5
(U25)
R562
C523
GR512
GR511
GR509
TS516
R560
C530
T501
R563
GR513
R564
C524
C515
C521
R566
TS517
GR519
C528
RE503
C518
R576
C526
R568
GR514
R569
R546
C519
GR503
R571
C522
GR518
C531
C527
TS518
GR517
C532
R572
GR516
R575
C533
R573
R574
TS519
C426
C427
R486
R487
R491
GR1612
SK25
R17

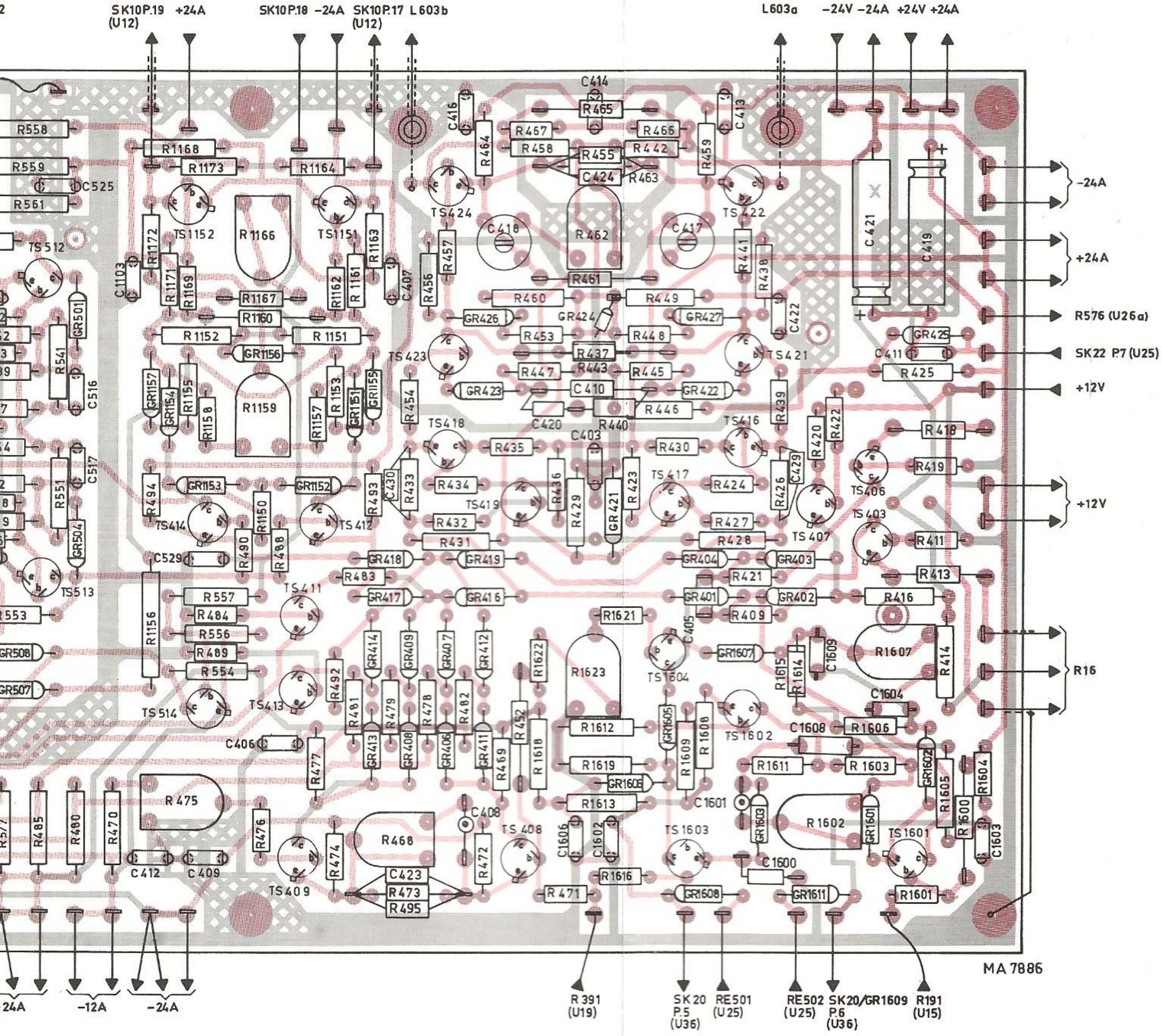



*Fig. XIV-7. Component location*

## ELECTRONIC SWITCH DRIVER AND INTERMEDIATE AMPLIFIER UNIT 26a, b

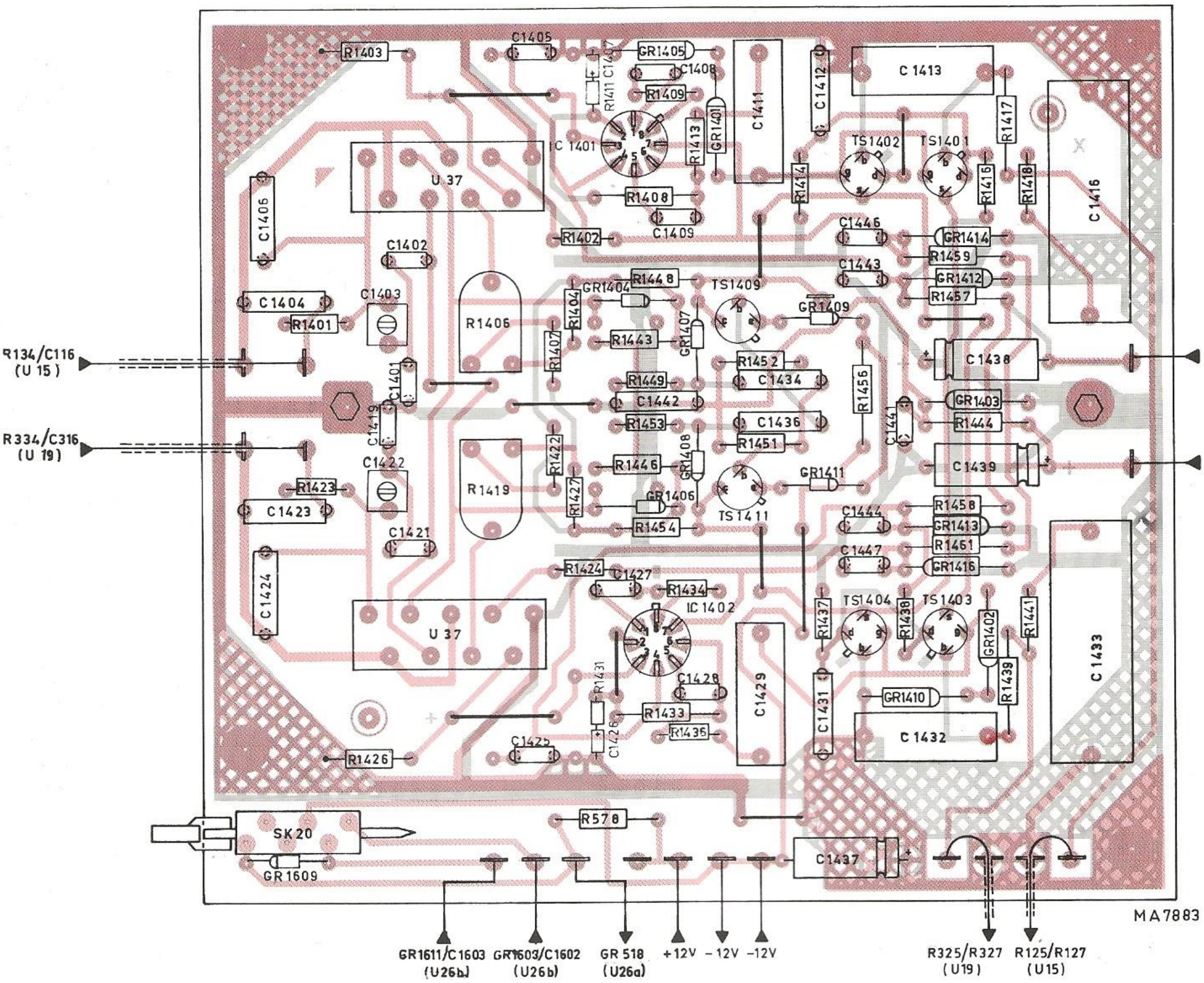
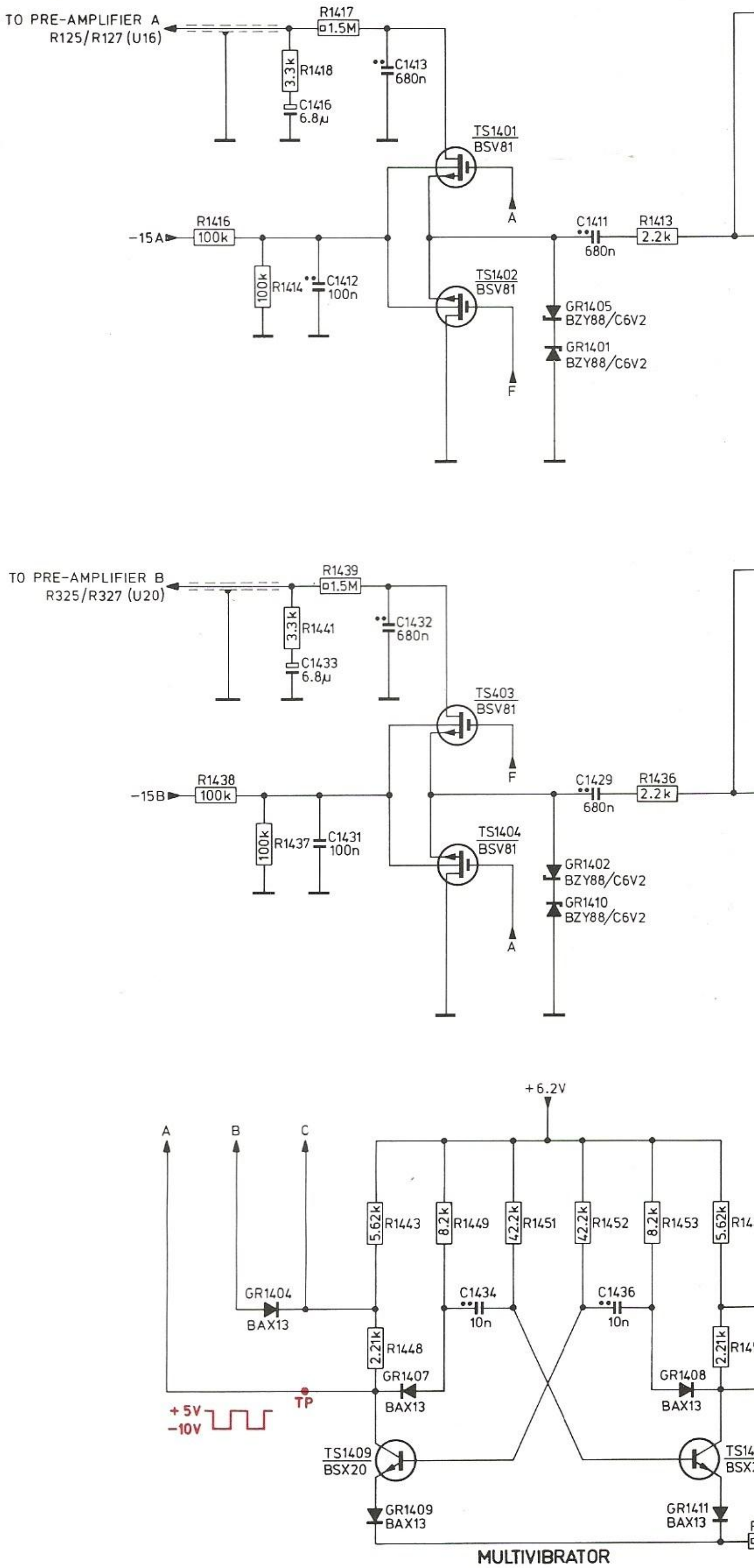



*Fig. XIV-8a. Component location*

## DRIFT REDUCTION AMPLIFIER UNIT U26c



TO PRE-AMPLIFIER A
R125/R127 (U16)
R1417
1.5M
R1418
3.3k
C1416
6.8µ
C1413
680n
TS1401
BSV81
-15A
R1416
100k
R1414
100k
C1412
100n
C1411
680n
R1413
2.2k
TS1402
BSV81
GR1405
BZY88/C6V2
GR1401
BZY88/C6V2
TO PRE-AMPLIFIER B
R325/R327 (U20)
R1439
1.5M
R1441
3.3k
C1433
6.8µ
C1432
680n
TS403
BSV81
-15B
R1438
100k
R1437
100k
C1431
100n
C1429
680n
R1436
2.2k
TS1404
BSV81
GR1402
BZY88/C6V2
GR1410
BZY88/C6V2
+6.2V
A
B
C
F
R1443
5.62k
R1449
8.2k
R1451
42.2k
R1452
42.2k
R1453
8.2k
5.62k
GR1404
BAX13
C1434
10n
C1436
10n
R1448
2.21k
2.21k
GR1407
BAX13
GR1408
BAX13
+5V
-10V
TP
TS1409
BSX20
GR1409
BAX13
GR1411
BAX13
MULTIVIBRATOR

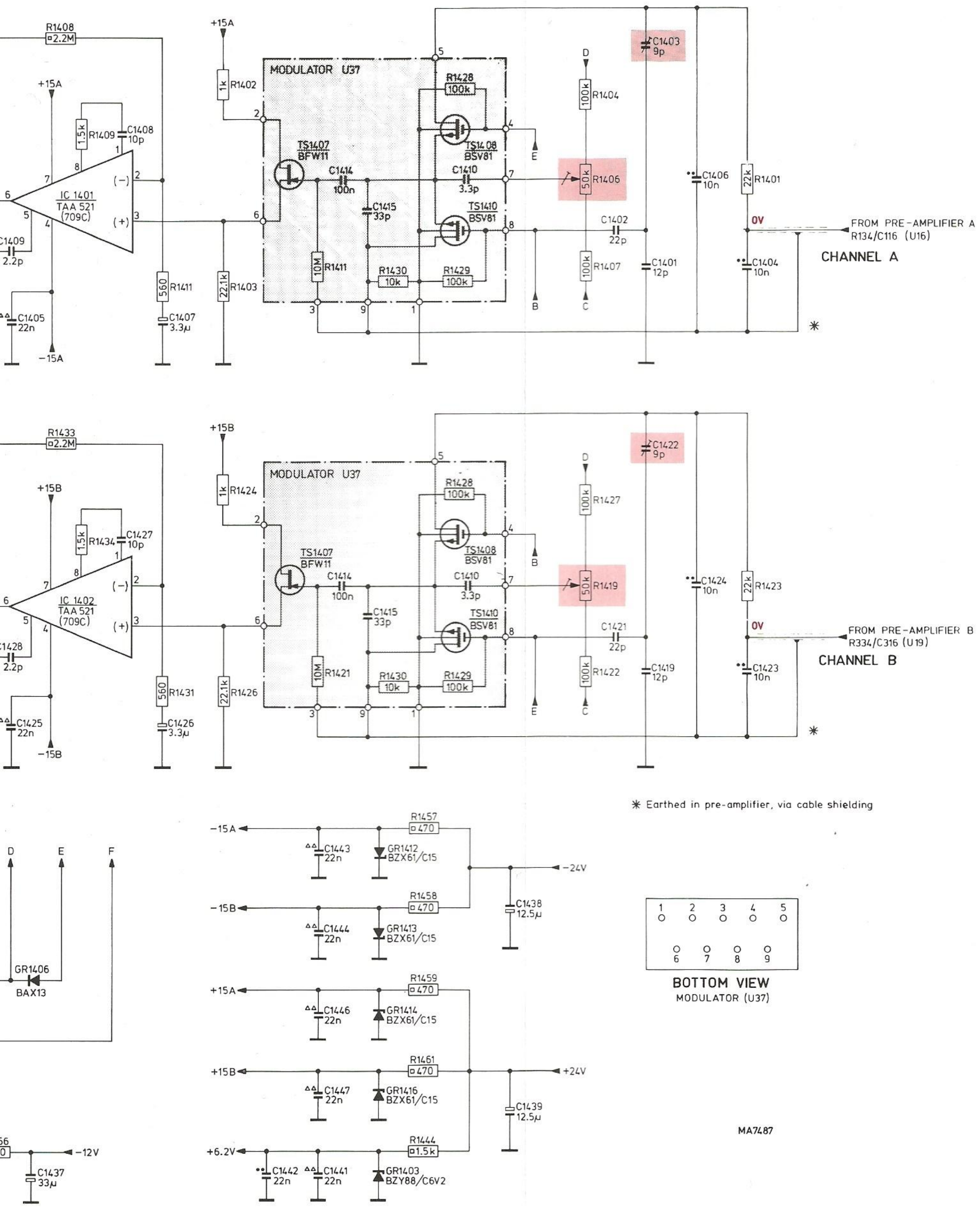



*Fig. XIV-8. Circuit diagram*

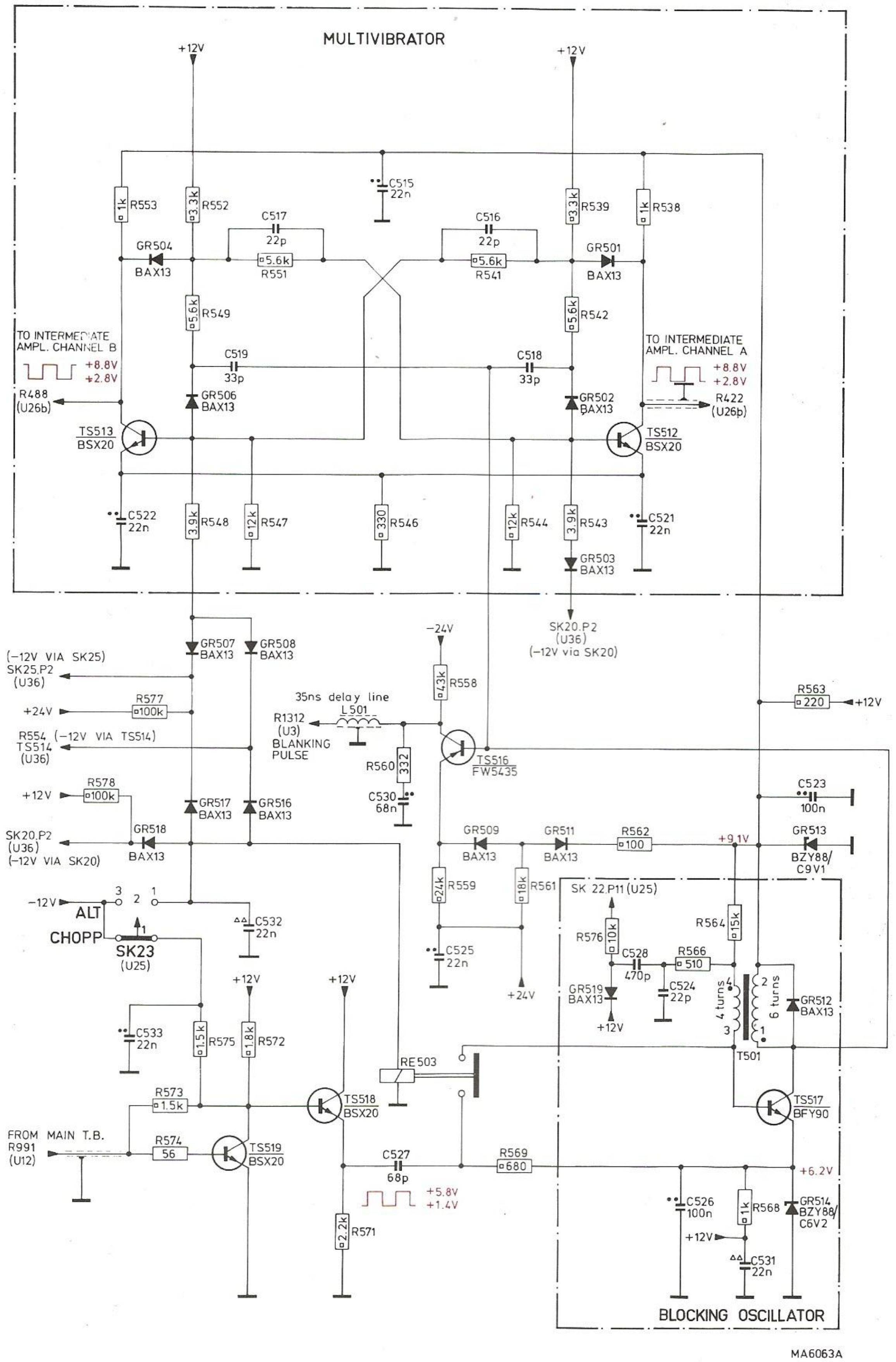



*Fig. XIV-9. Circuit diagram*

**(for component location see Fig. XIV-7)**

## ELECTRONIC SWITCH DRIVER UNIT U26a

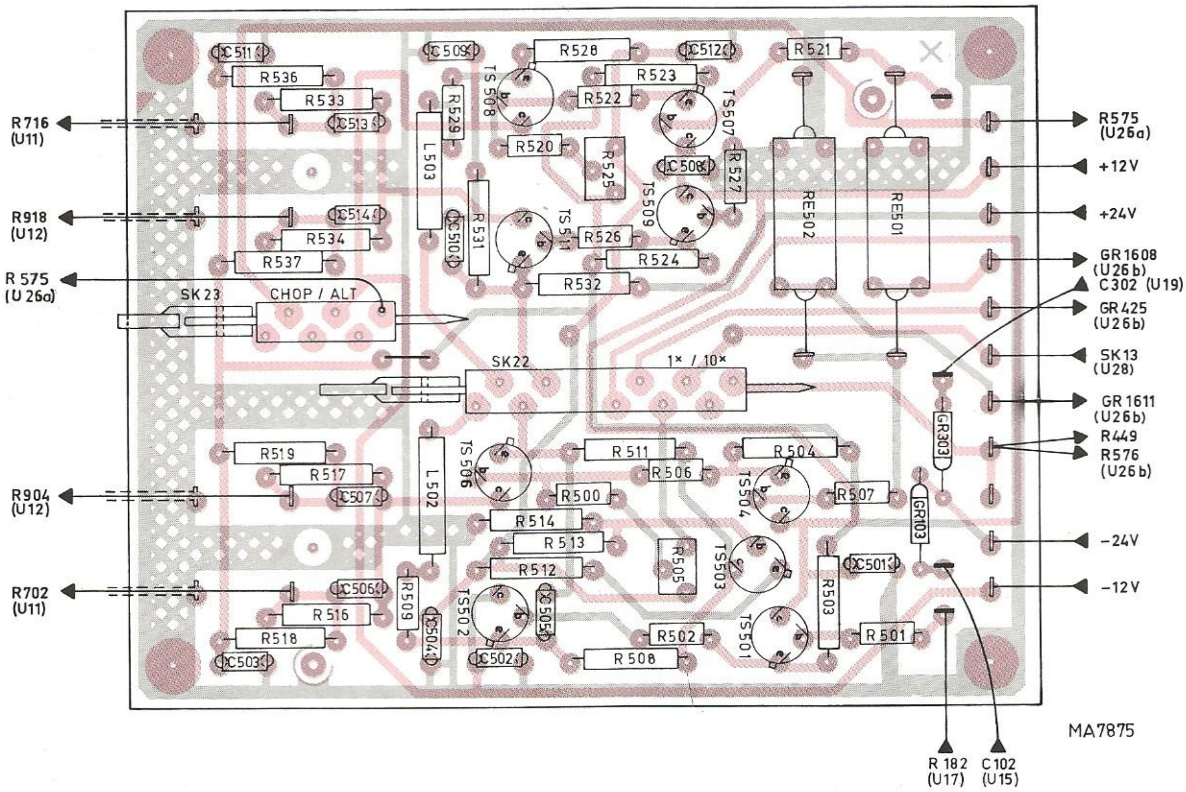



*Fig. XIV-10a. Component location*

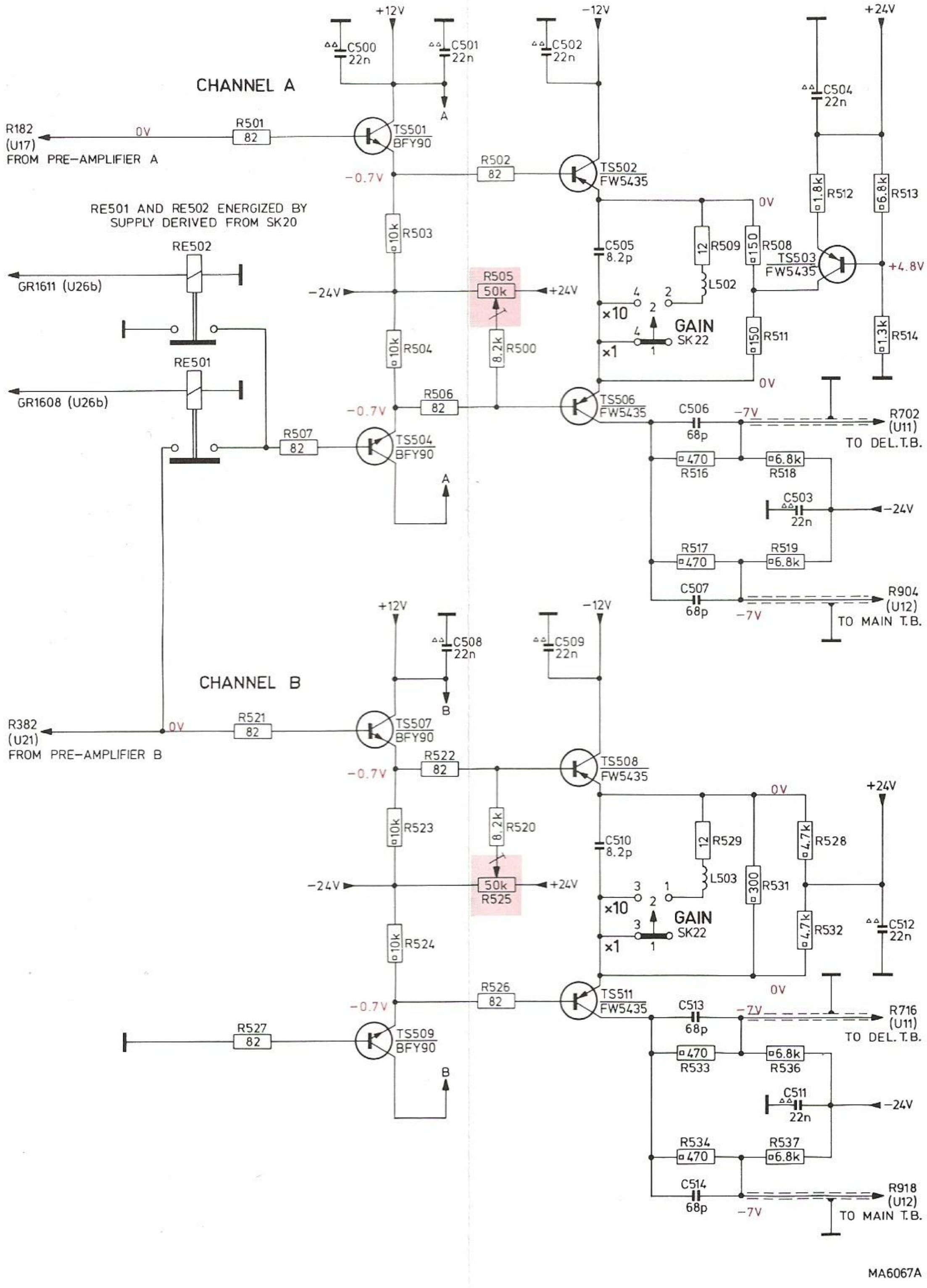



*Fig. XIV-10. Circuit diagram*

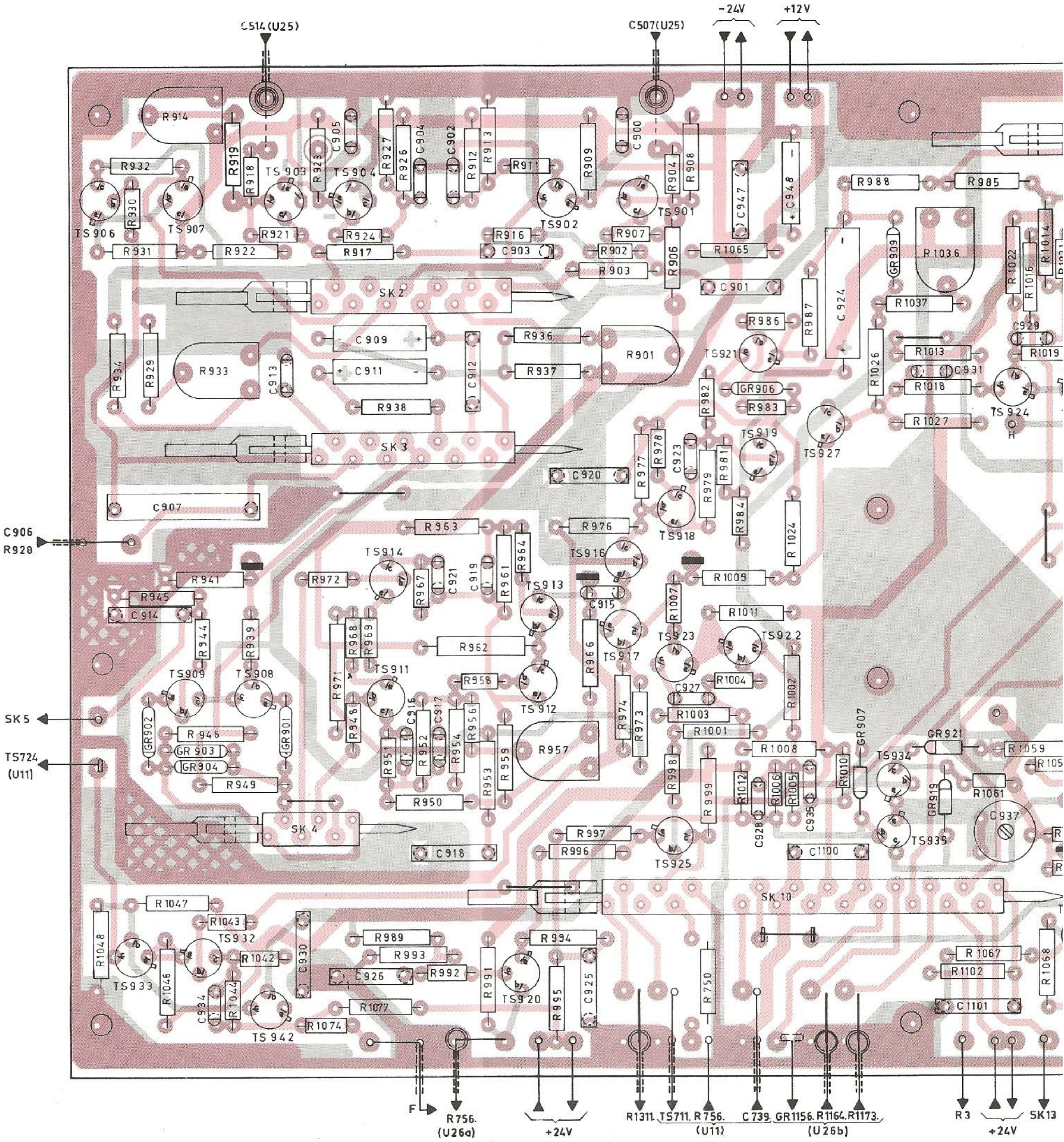
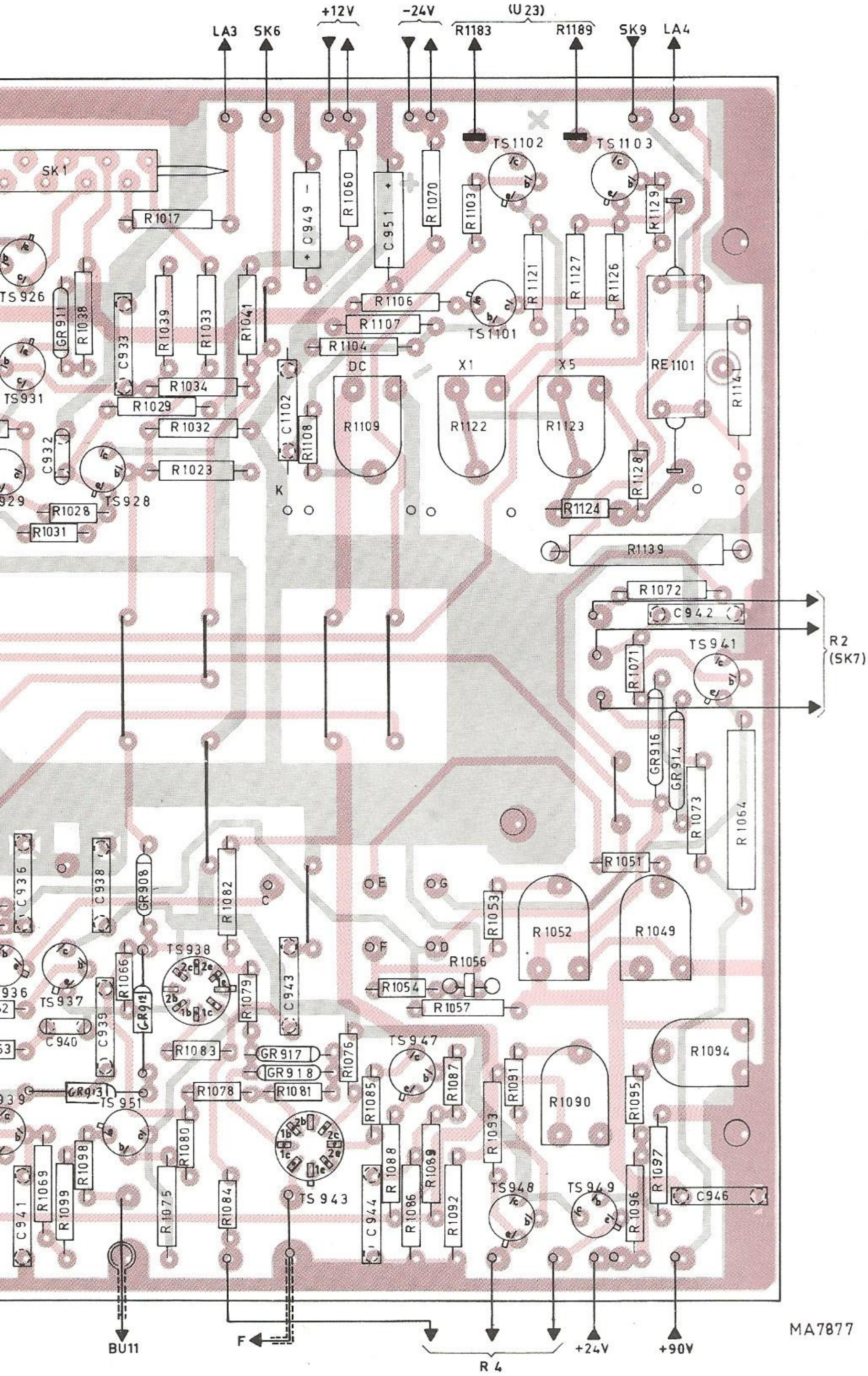



*Fig. XIV-11b. Component location*




**MAIN TIME BASE  UNIT 12**

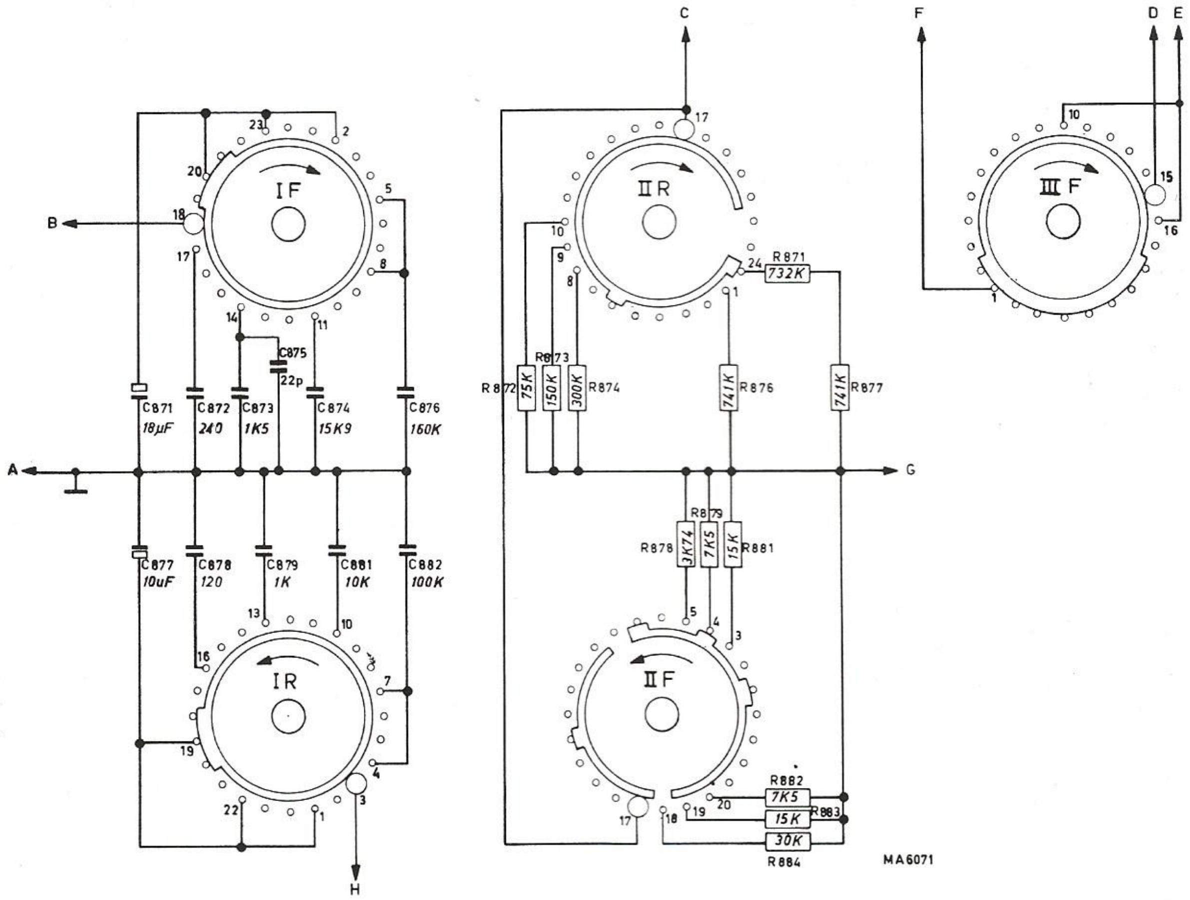
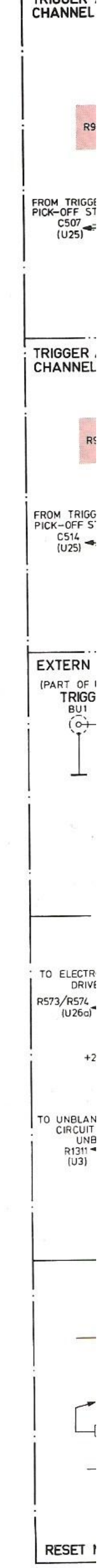
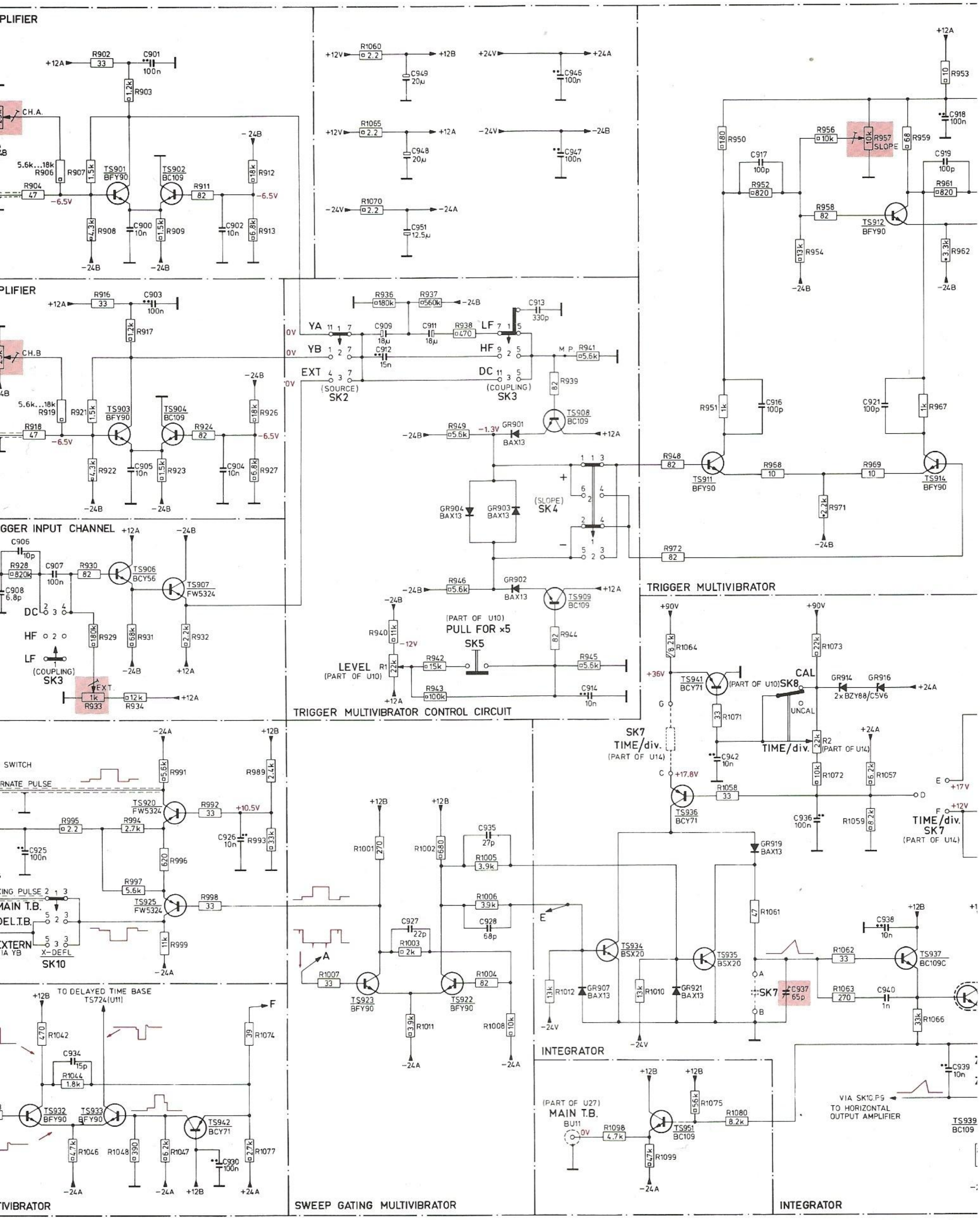
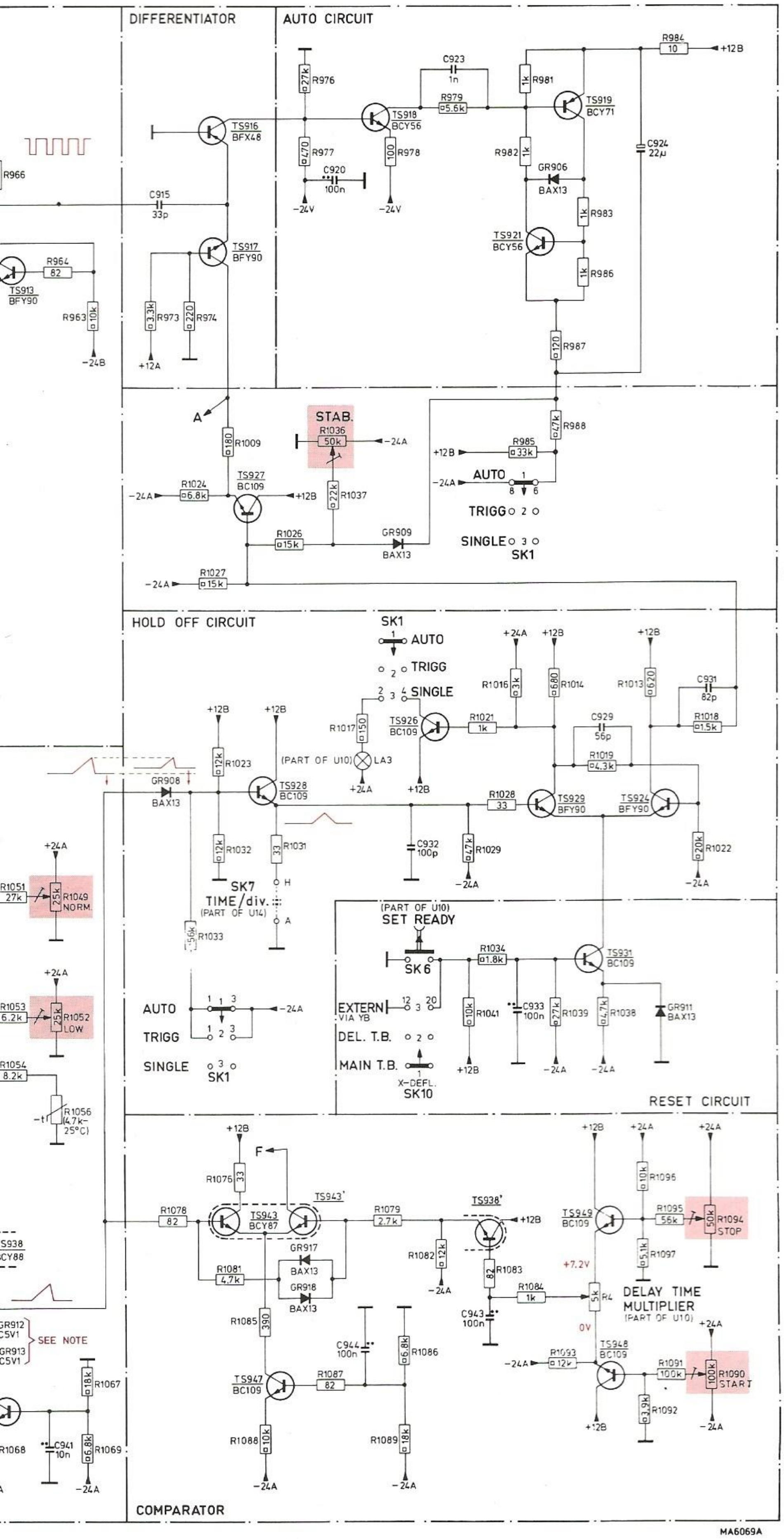
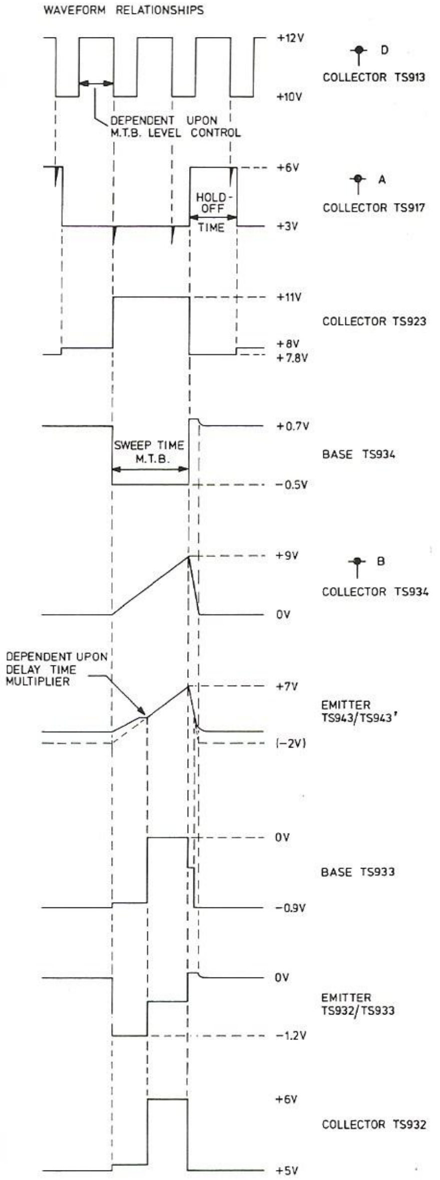



*Fig. XIV-11a. TIME/div. switch SK7*




PLIFIER
PLIFIER
GGER INPUT CHANNEL
TRIGGER MULTIVIBRATOR CONTROL CIRCUIT
TRIGGER MULTIVIBRATOR
SWEEP GATING MULTIVIBRATOR
INTEGRATOR
INTEGRATOR
TIVIBRATOR
CH.A.
CH.B
TS901 BFY90
TS902 BC109
TS903 BFY90
TS904 BC109
TS906 BCY56
TS907 FW5324
TS908 BC109
TS909 BC109
TS911 BFY90
TS912 BFY90
TS914 BFY90
TS920 FW5324
TS925 FW5324
TS923 BFY90
TS922 BFY90
TS932 BFY90
TS933 BFY90
TS942 BCY71
TS934 BSX20
TS935 BSX20
TS936 BCY71
TS937 BC109C
TS941 BCY71
TS951 BC109
TS939 BC109
YA
YB
EXT
(SOURCE)
SK2
LF
HF
DC
(COUPLING)
SK3
(SLOPE)
SK4
LEVEL
(PART OF U10)
(PART OF U10)
PULL FOR ×5
SK5
R957 SLOPE
SK7
TIME/div.
(PART OF U14)
CAL
UNCAL
SK8
(PART OF U10)
TIME/div.
R2 (PART OF U14)
TIME/div.
SK7
(PART OF U14)
(COUPLING)
SK3
EXT.
R933
MAIN T.B.
DEL.T.B.
EXTERN
VIA YB
X-DEFL
SK10
TO DELAYED TIME BASE
TS724(U11)
(PART OF U27)
MAIN T.B.
BU11
VIA SK10.P5
TO HORIZONTAL
OUTPUT AMPLIFIER
GR901 BAX13
GR902 BAX13
GR903 BAX13
GR904 BAX13
GR907 BAX13
GR919 BAX13
GR921 BAX13
GR914
GR916
2×BZY88/C5V6
C937 65p
+12A
+12B
+24A
-24A
-24B
+90V
+36V
+17.8V
+17V
+12V
-6.5V
+10.5V
-1.3V
-12V




NOTE:

SELECTED ZENER DIODES: (BZY88/C5V1)

$U_{GR913} + U_{GR912} = U_{GR713} + U_{GR714}$

(PART OF M.T.B.) (PART OF DEL. T.B.)

*Fig. XIV-11. Circuit diagram*

**MAIN TIME BASE UNIT 12**

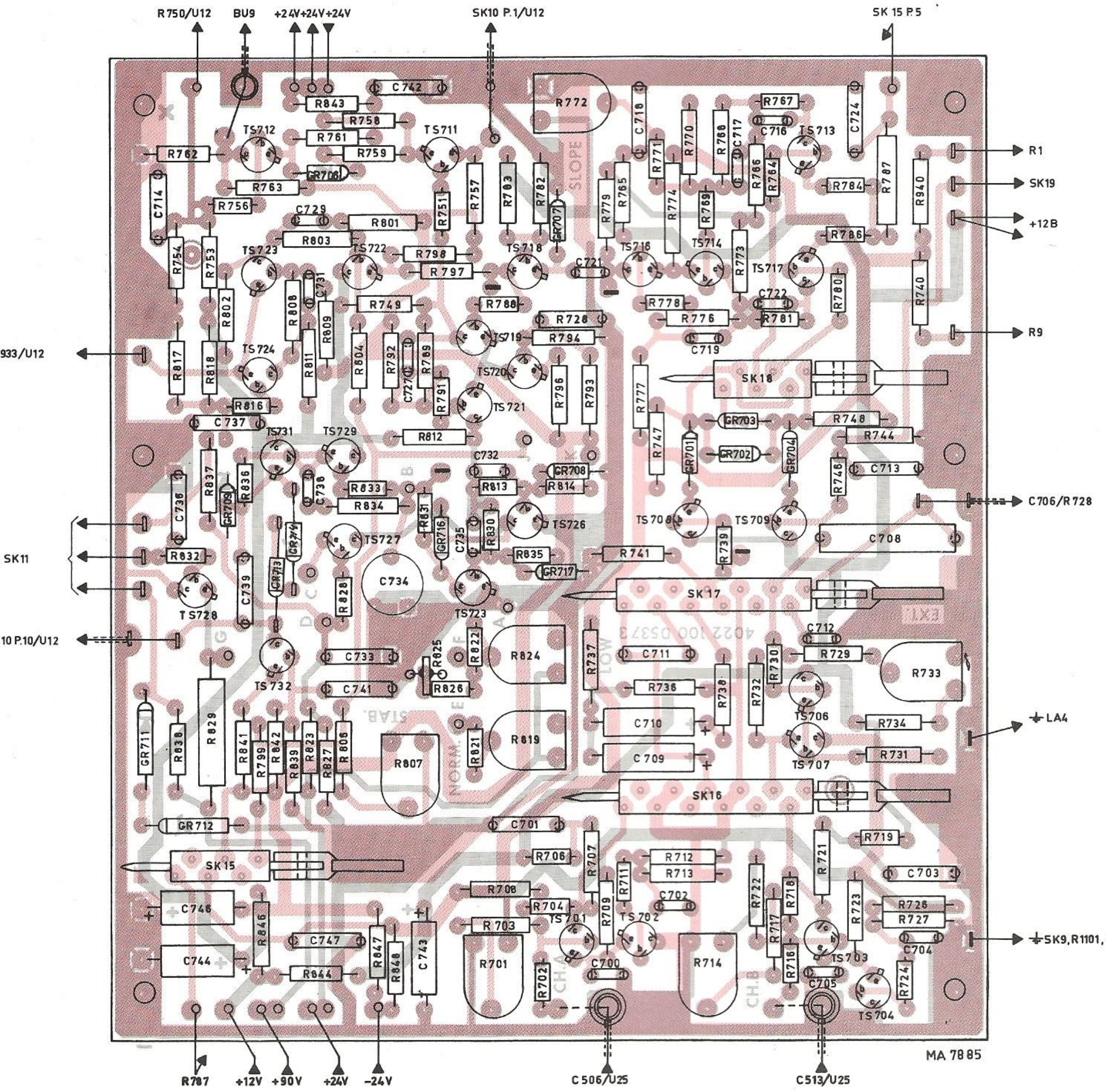
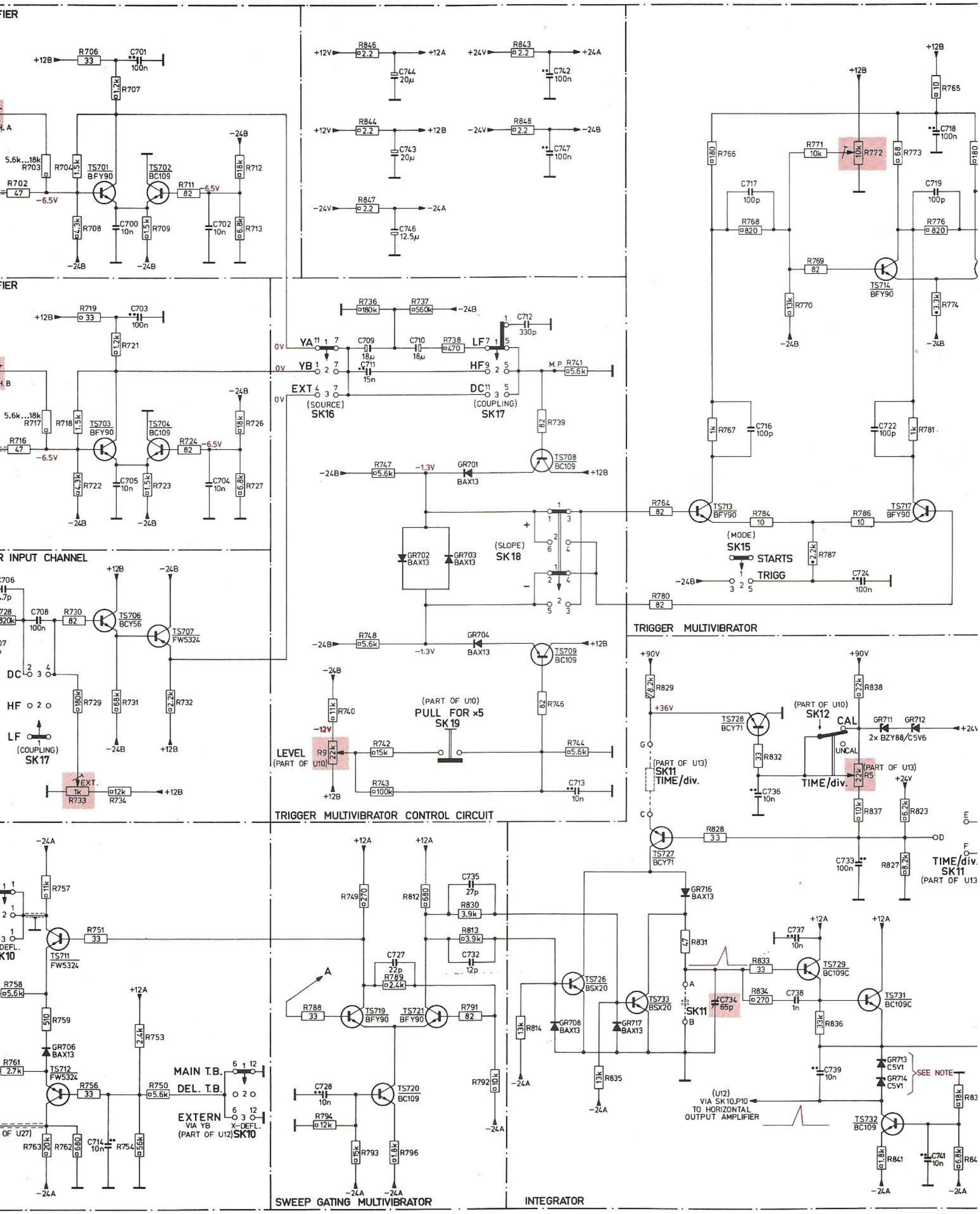
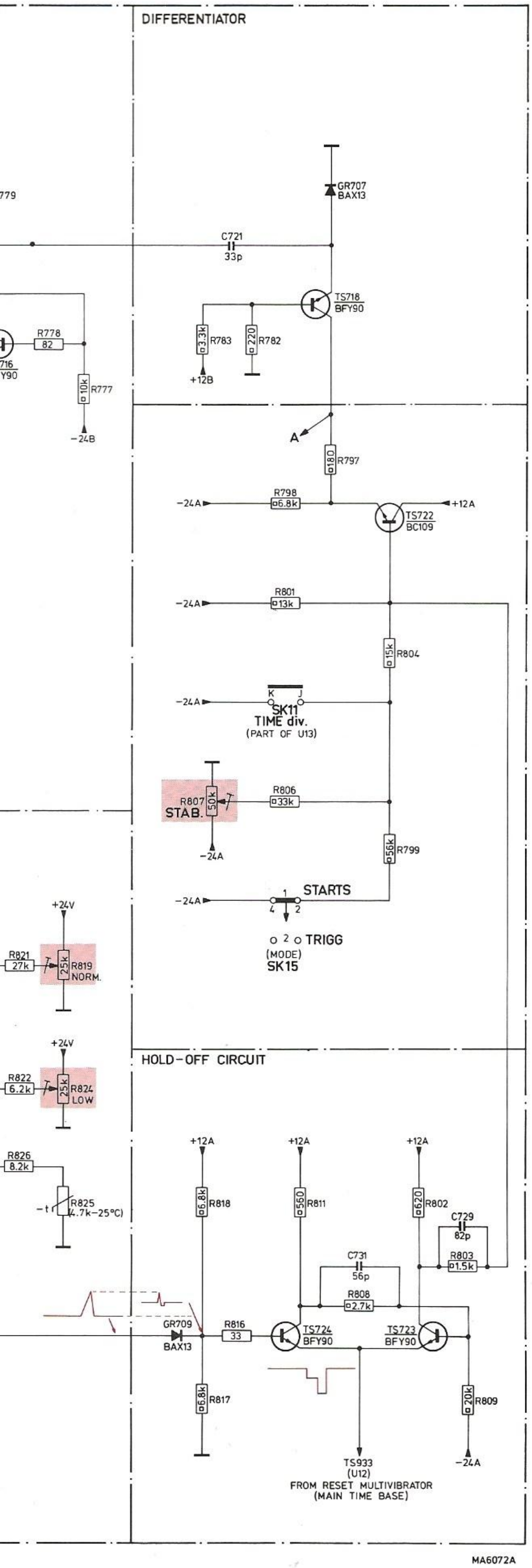
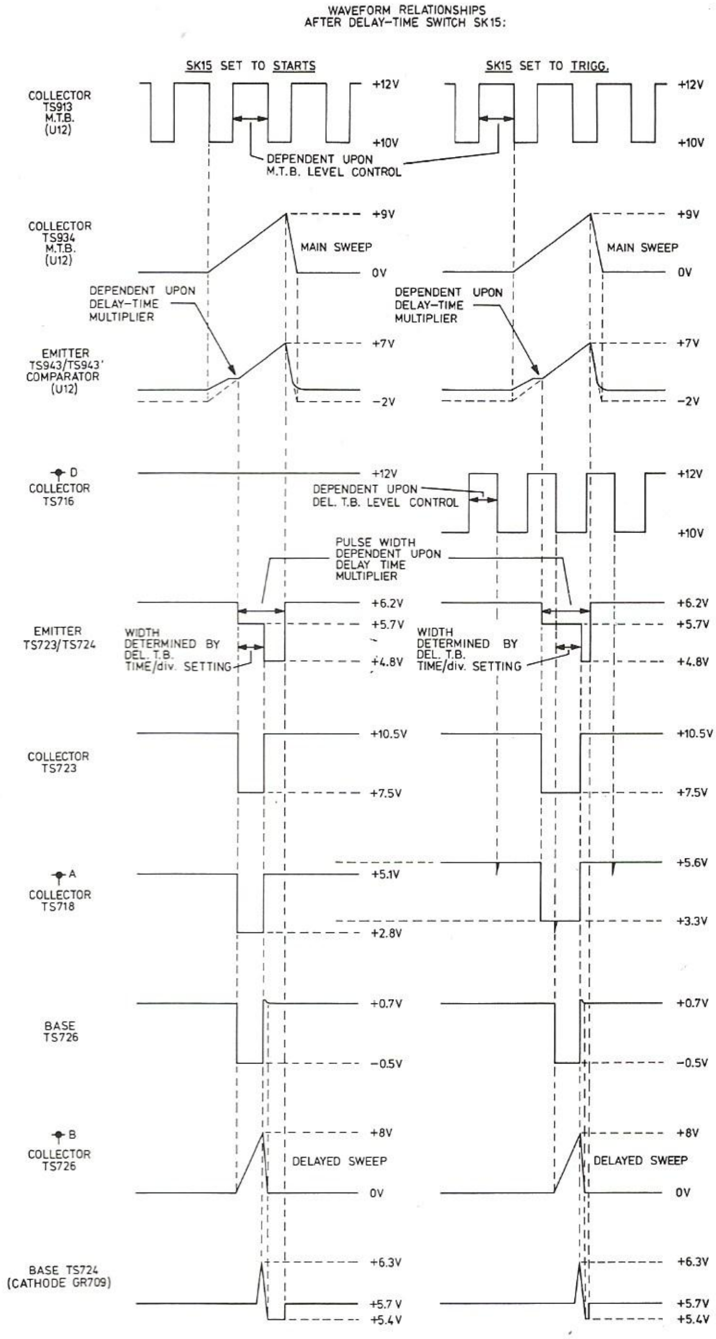



*Fig. XIV-12b. Component location*



FIER
FIER
R INPUT CHANNEL
TRIGGER MULTIVIBRATOR CONTROL CIRCUIT
TRIGGER MULTIVIBRATOR
SWEEP GATING MULTIVIBRATOR
INTEGRATOR
(SOURCE)
SK16
(COUPLING)
SK17
(SLOPE)
SK18
(MODE)
SK15
STARTS
TRIGG
LEVEL
(PART OF U10)
(PART OF U10)
PULL FOR ×5
SK19
(PART OF U10)
SK12
CAL
UNCAL
TIME/div.
(PART OF U13)
SK11
TIME/div.
MAIN T.B.
DEL. T.B.
EXTERN
VIA YB
(PART OF U12)
X-DEFL.
SK10
(U12)
VIA SK10.P10
TO HORIZONTAL
OUTPUT AMPLIFIER
SEE NOTE
TS701 BFY90
TS702 BC109
TS703 BFY90
TS704 BC109
TS706 BCY56
TS707 FW5324
TS708 BC109
TS709 BC109
TS711 FW5324
TS712 FW5324
TS713 BFY90
TS714 BFY90
TS717 BFY90
TS719 BFY90
TS720 BC109
TS721 BFY90
TS726 BSX20
TS727 BCY71
TS728 BCY71
TS729 BC109C
TS731 BC109C
TS732 BC109
TS733 BSX20




NOTE:
SELECTED ZENER DIODES: (BZY88/C5V1)

$U_{GR912} + U_{GR913} = U_{GR713} + U_{GR714}$
(PART OF M.T.B.) (PART OF DEL.T.B.)

*Fig. XIV-12. Circuit diagram*

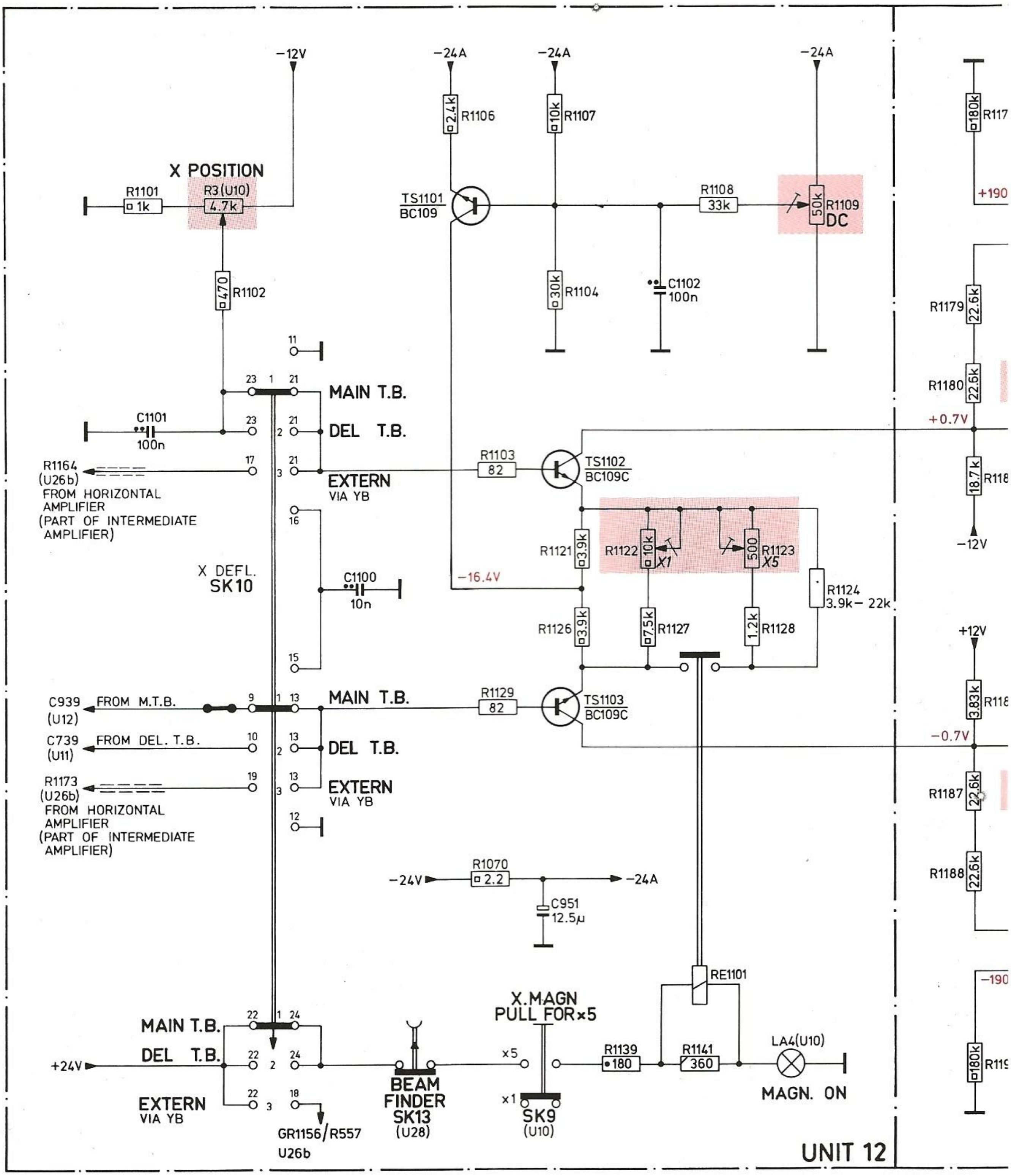
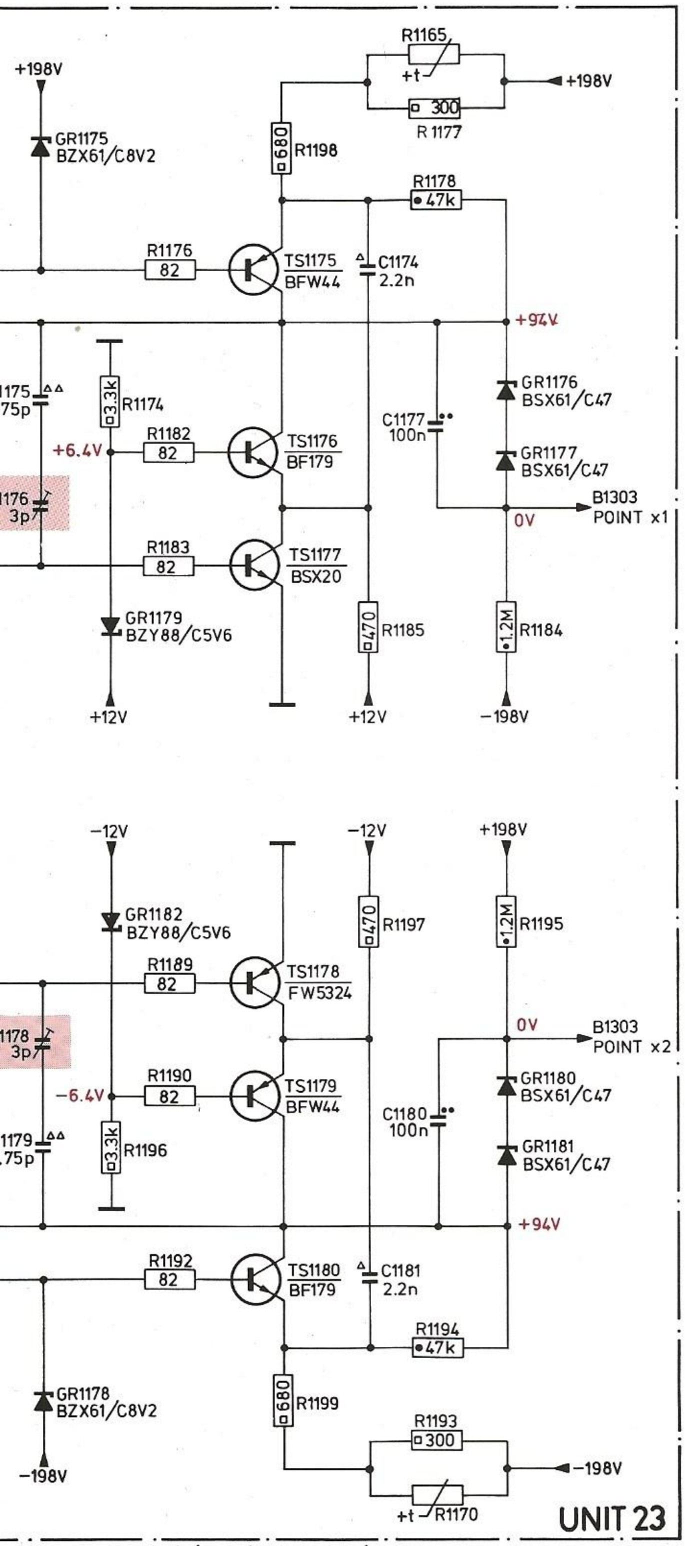



*Fig. XIV-13. Circuit diagram*




R1165=R1170 (50Ω ±15Ω at 25°C)

MA6075A

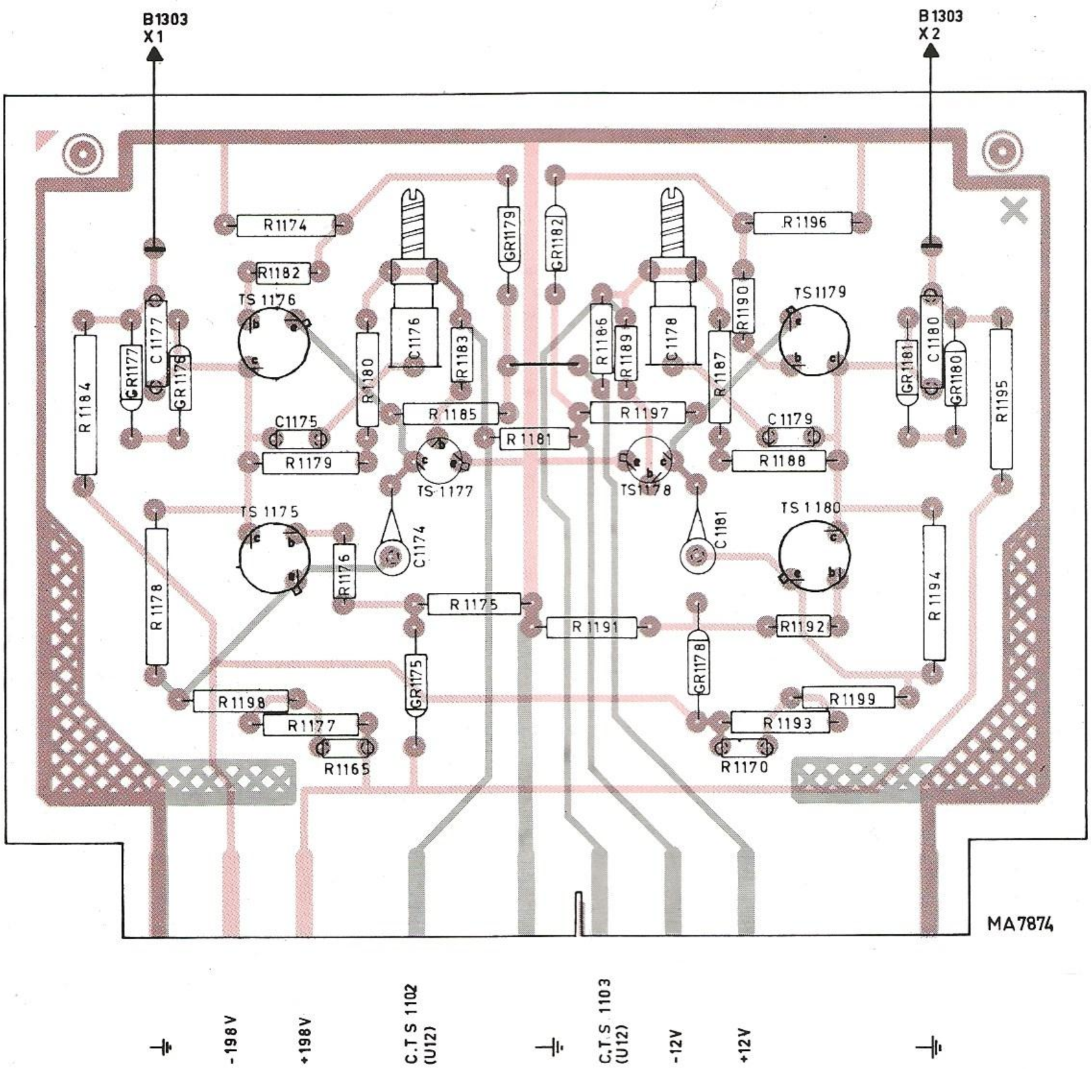



*Fig. XIV-13a. Component location*

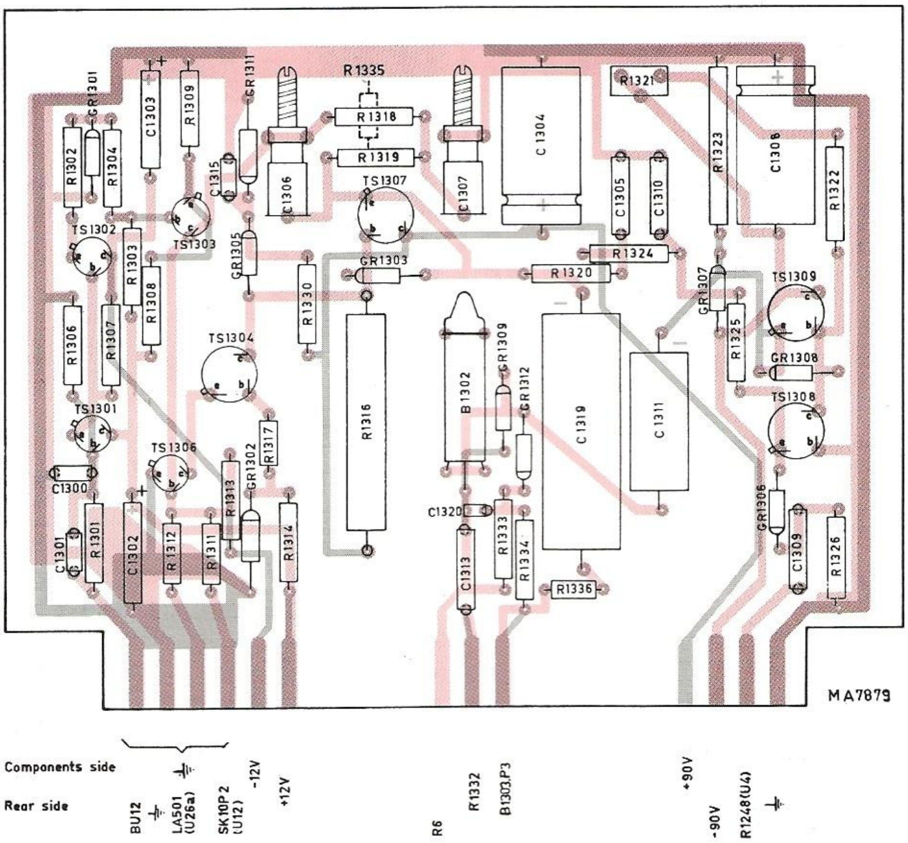
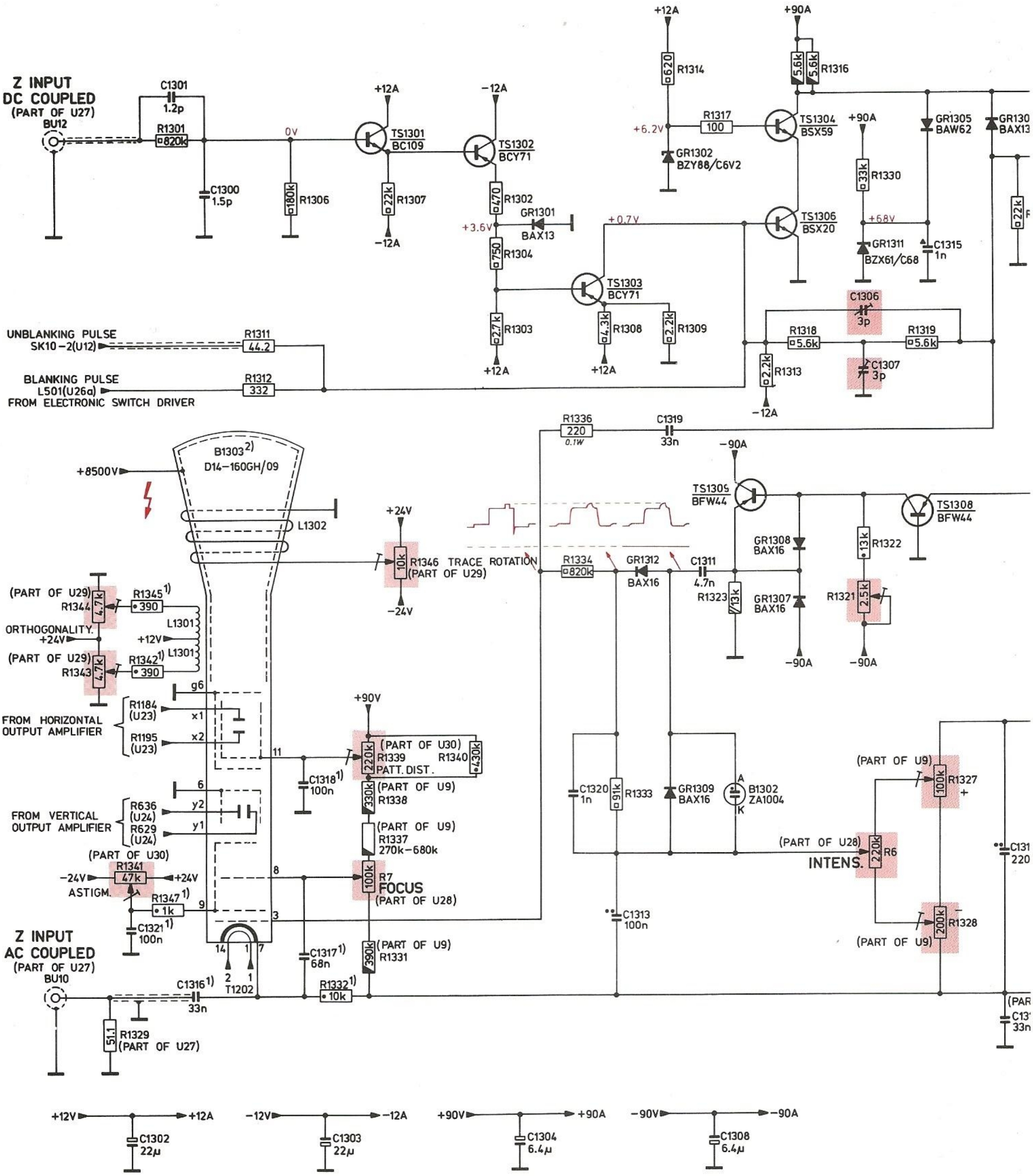



*Fig. XIV-14a. Component location*


Z INPUT
DC COUPLED
(PART OF U27)
BU12
C1301
1.2p
R1301
820k
C1300
1.5p
0V
R1306
180k
+12A
TS1301
BC109
R1307
22k
-12A
TS1302
BCY71
R1302
470
+3.6V
GR1301
BAX13
R1304
750
R1303
2.7k
+12A
TS1303
BCY71
R1308
4.3k
R1309
2.2k
+0.7V
R1314
620
+6.2V
R1317
100
GR1302
BZY88/C6V2
+90A
R1316
5.6k
5.6k
TS1304
BSX59
TS1306
BSX20
R1330
33k
+6.8V
GR1311
BZX61/C68
C1315
1n
GR1305
BAW62
C1306
3p
C1307
3p
R1318
5.6k
R1319
5.6k
R1313
2.2k
-12A
UNBLANKING PULSE
SK10-2(U12)
R1311
44.2
BLANKING PULSE
L501(U26a)
FROM ELECTRONIC SWITCH DRIVER
R1312
332
R1336
220
0.1W
C1319
33n
-90A
TS1305
BFW44
TS1308
BFW44
+8500V
B1303 2)
D14-160GH/09
L1302
+24V
R1346
10k
TRACE ROTATION
(PART OF U29)
-24V
R1334
820k
GR1312
BAX16
C1311
4.7n
R1323
13k
GR1308
BAX16
GR1307
BAX16
R1322
13k
R1321
2.5k
(PART OF U29)
R1344
4.7k
R1345 1)
390
L1301
ORTHOGONALITY
+24V
+12V
(PART OF U29)
R1343
4.7k
R1342 1)
390
g6
R1184
(U23)
x1
x2
R1195
(U23)
FROM HORIZONTAL OUTPUT AMPLIFIER
11
C1318 1)
100n
+90V
R1339
220k
(PART OF U30)
PATT. DIST.
R1340
430k
R1338
330k
(PART OF U9)
R1337
270k-680k
(PART OF U9)
FROM VERTICAL OUTPUT AMPLIFIER
R636
(U24)
R629
(U24)
y2
y1
6
(PART OF U30)
R1341
47k
ASTIGM.
+24V
-24V
R1347 1)
1k
C1321 1)
100n
8
9
3
R7
100k
FOCUS
(PART OF U28)
C1317 1)
68n
R1331
390k
(PART OF U9)
C1320
1n
R1333
91k
GR1309
BAX16
B1302
ZA1004
A
K
C1313
100n
(PART OF U28)
R6
220k
INTENS.
(PART OF U9)
R1327
100k
R1328
200k
Z INPUT
AC COUPLED
(PART OF U27)
BU10
C1316 1)
33n
14
1
7
2
1
T1202
R1332 1)
10k
R1329
51.1
(PART OF U27)
+12V
+12A
C1302
22μ
-12V
-12A
C1303
22μ
+90V
+90A
C1304
6.4μ
-90V
-90A
C1308
6.4μ

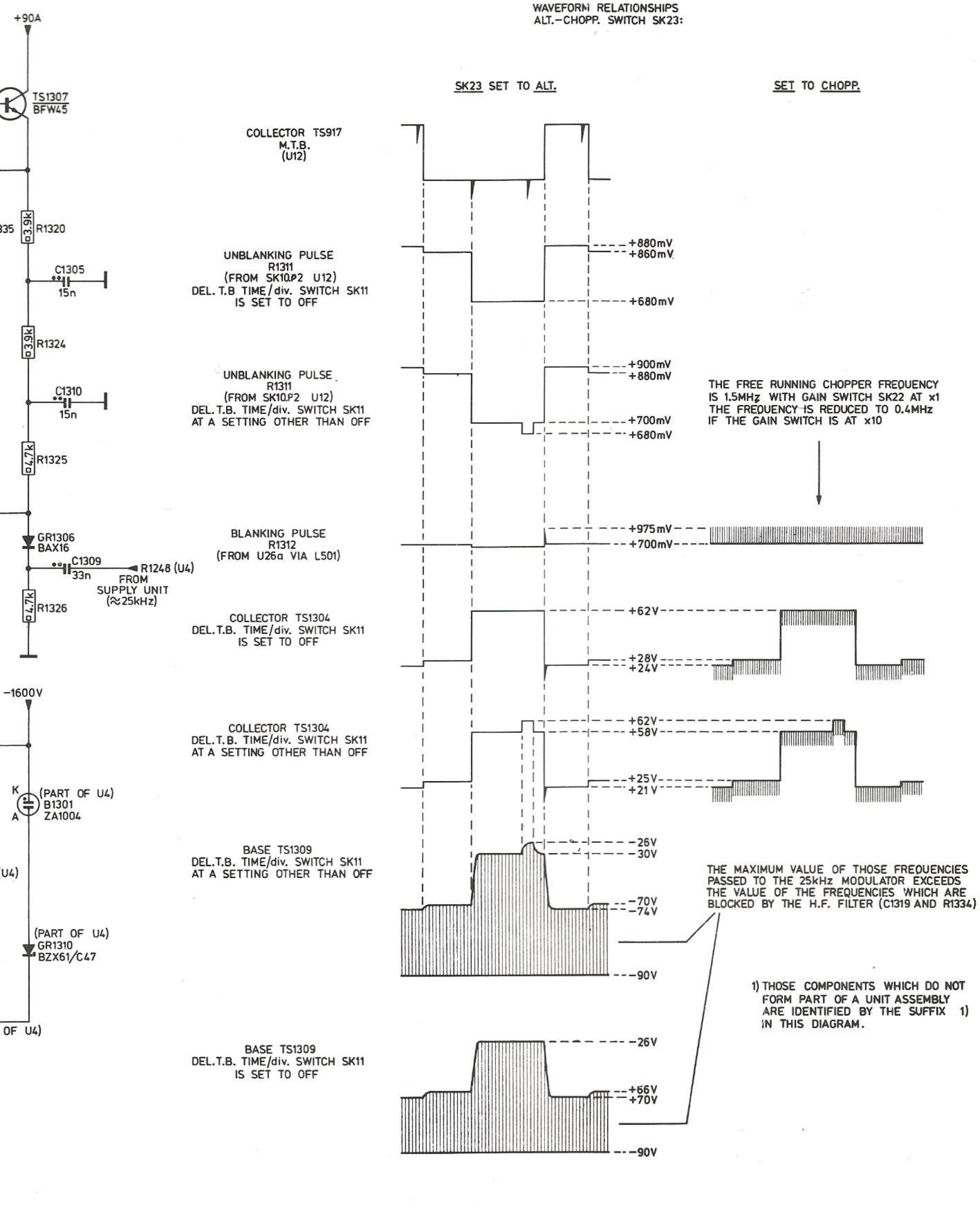



*Fig. XIV-14. Circuit diagram*

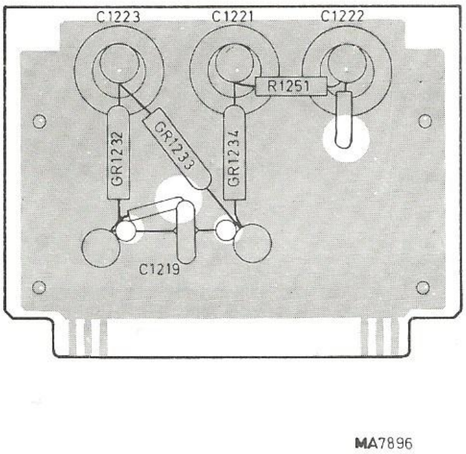



*Fig. XIV-15a. High tension unit*

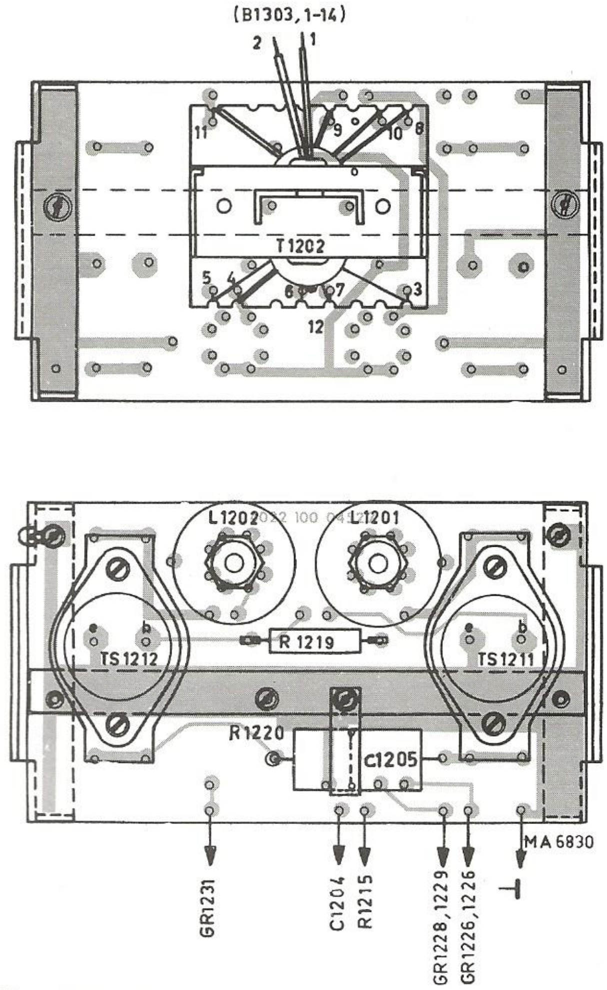



*Fig. XIV-5b. Chopper unit*

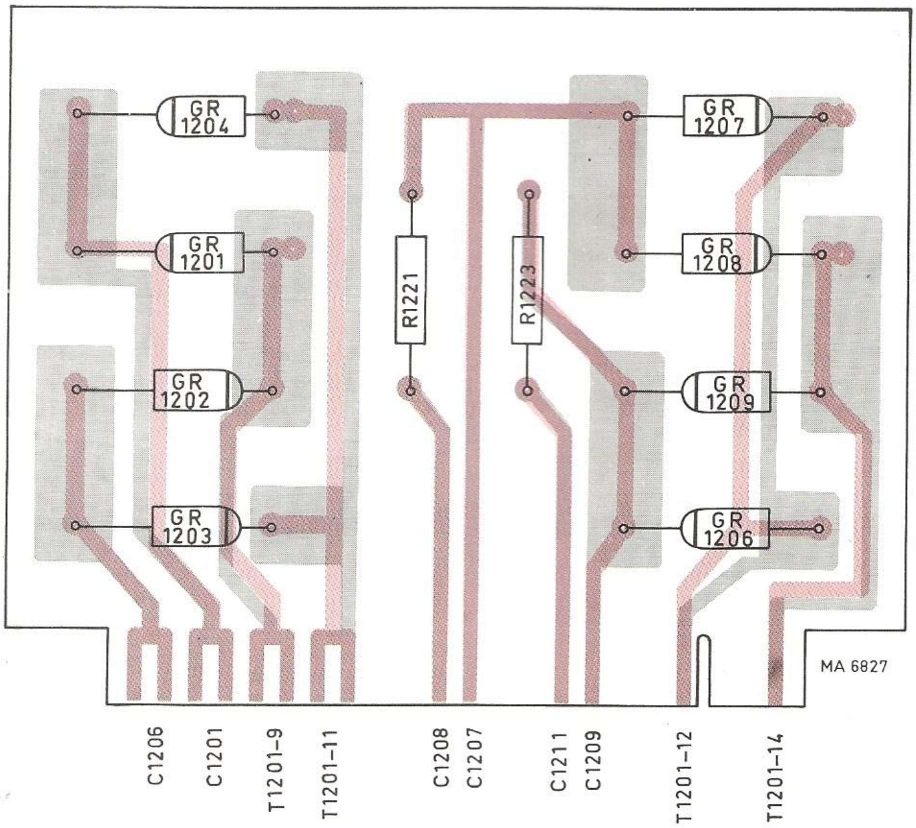



*Fig. XIV-15c. Diode panel*

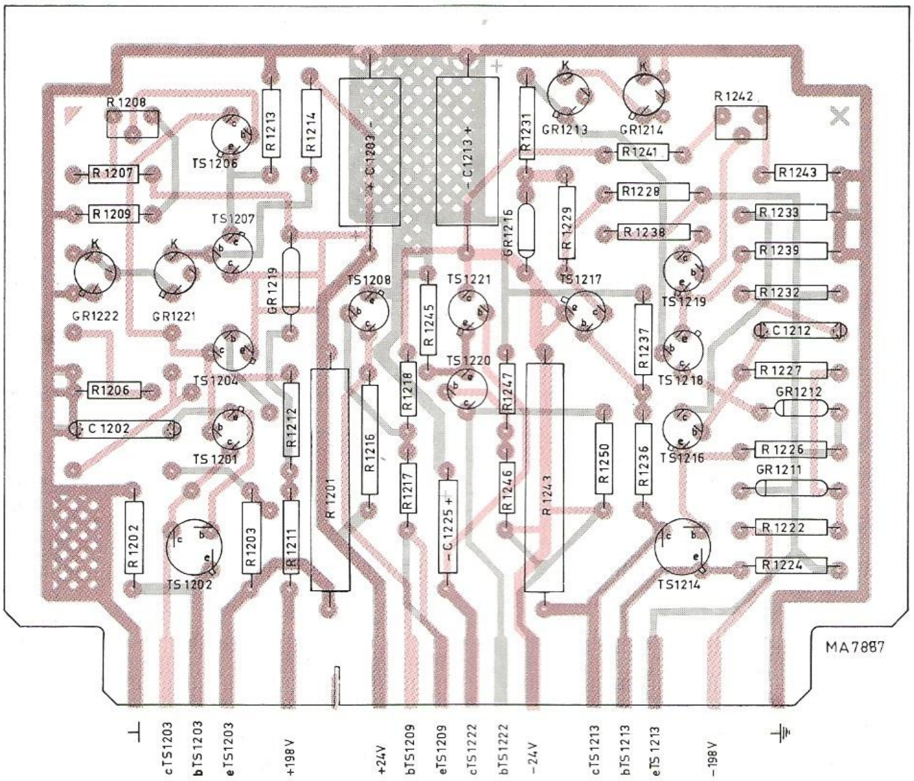



*Fig. XIV-15d. Supply panel*

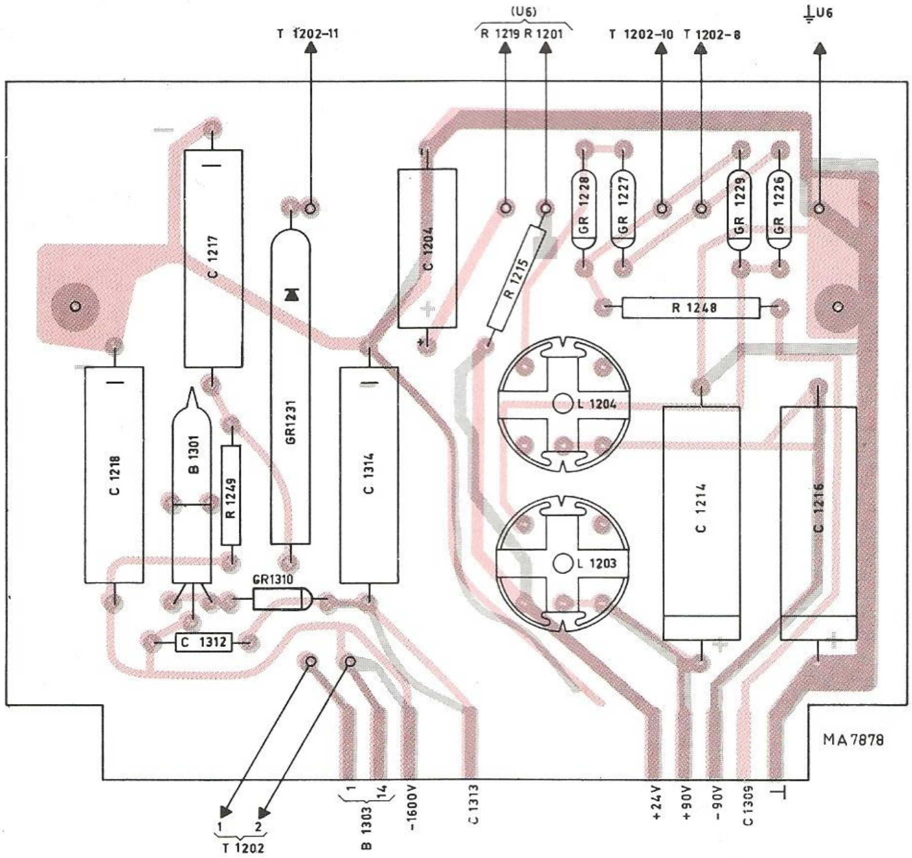
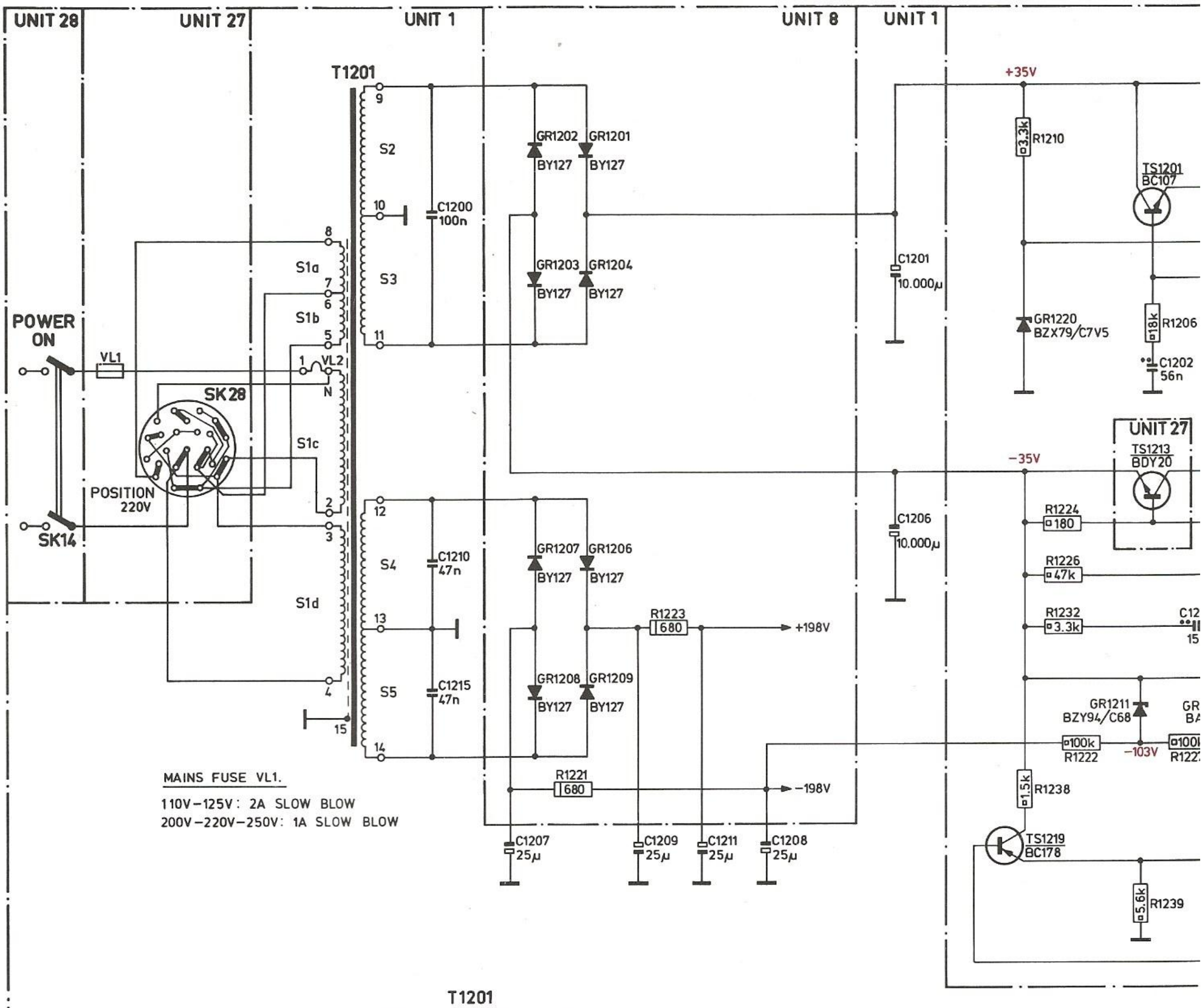
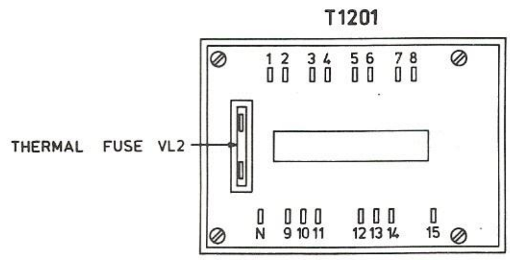



*Fig. XIV-15e. Chopper panel*

component location

POWER SUPPLY


UNIT 28
UNIT 27
UNIT 1
UNIT 8
UNIT 1
T1201
POWER ON
VL1
VL2
SK28
POSITION 220V
SK14
S1a
S1b
S1c
S1d
S2
S3
S4
S5
C1200 100n
C1210 47n
C1215 47n
GR1202 BY127
GR1201 BY127
GR1203 BY127
GR1204 BY127
GR1207 BY127
GR1206 BY127
GR1208 BY127
GR1209 BY127
R1223 680
+198V
R1221 680
-198V
C1207 25µ
C1209 25µ
C1211 25µ
C1208 25µ
C1201 10.000µ
C1206 10.000µ
+35V
-35V
R1210 3,3k
GR1220 BZX79/C7V5
TS1201 BC107
R1206 18k
C1202 56n
UNIT 27
TS1213 BDY20
R1224 180
R1226 47k
R1232 3.3k
GR1211 BZY94/C68
R1222 100k
-103V
R1238 1,5k
TS1219 BC178
R1239 5,6k
MAINS FUSE VL1.
110V-125V: 2A SLOW BLOW
200V-220V-250V: 1A SLOW BLOW


T1201
1 2 3 4 5 6 7 8
THERMAL FUSE VL2
N 9 10 11 12 13 14 15

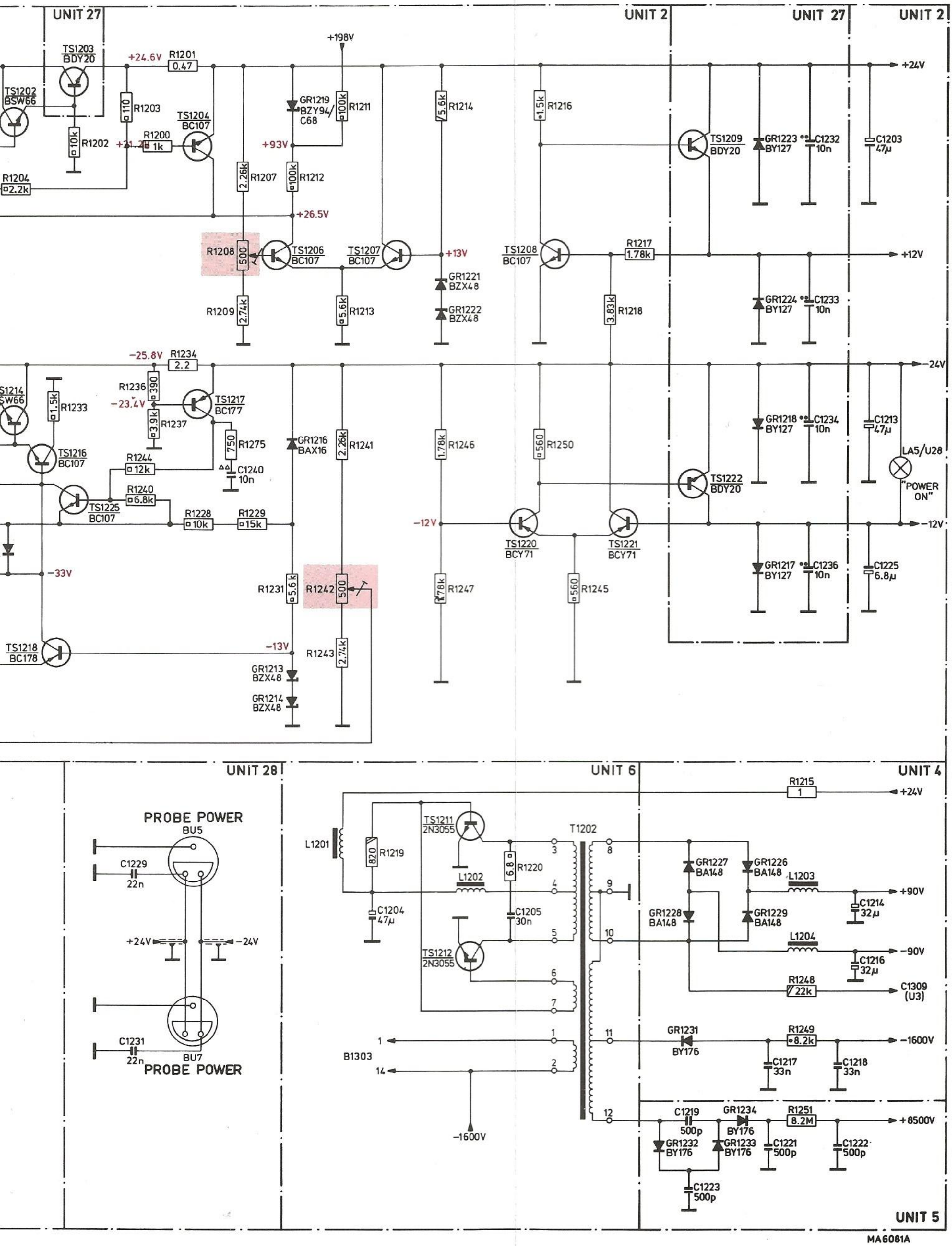



*Fig. XIV-15. Circuit diagram*

**POWER SUPPLY**

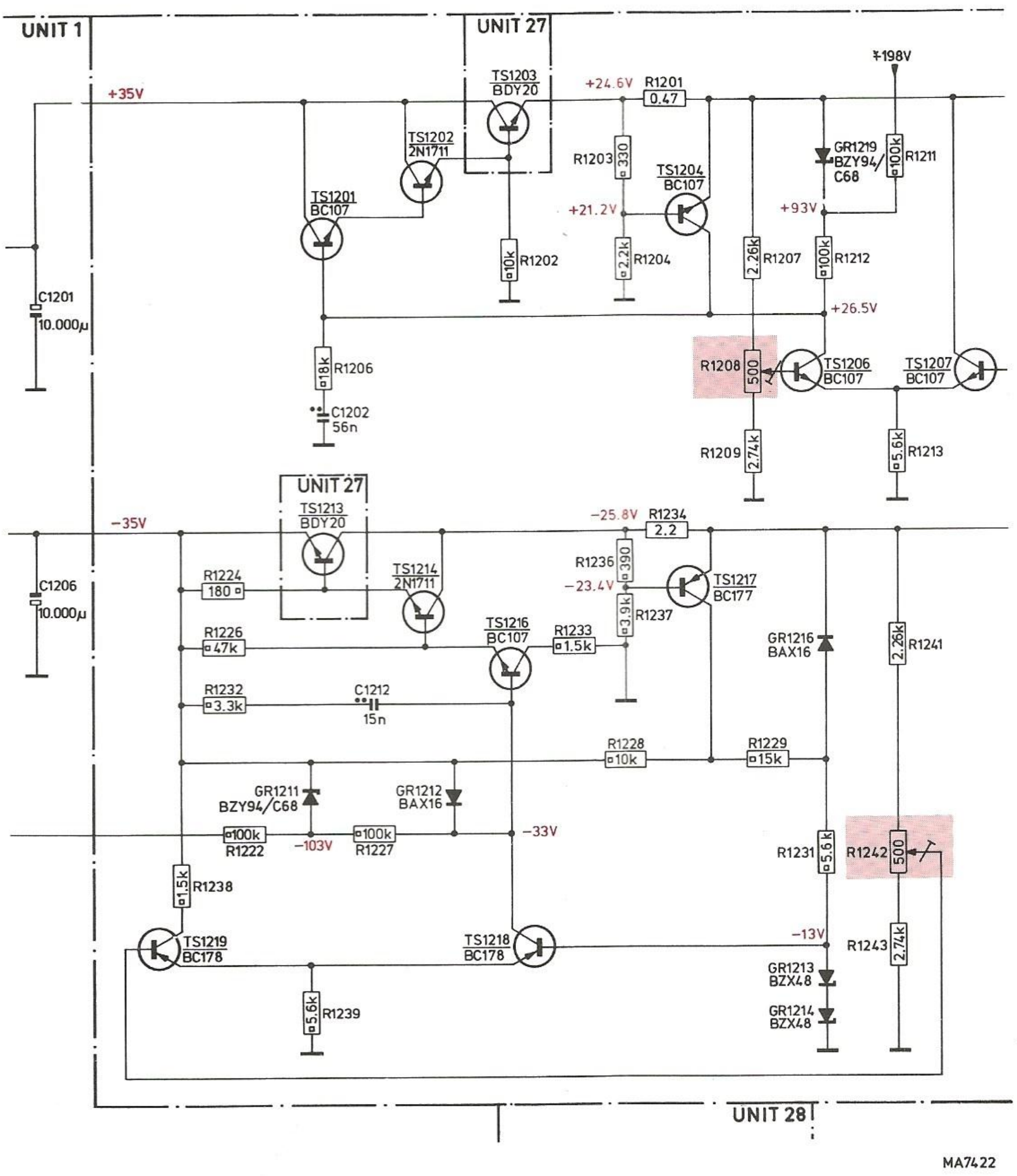



*Fig. XIV-16. Detailed circuit diagram*

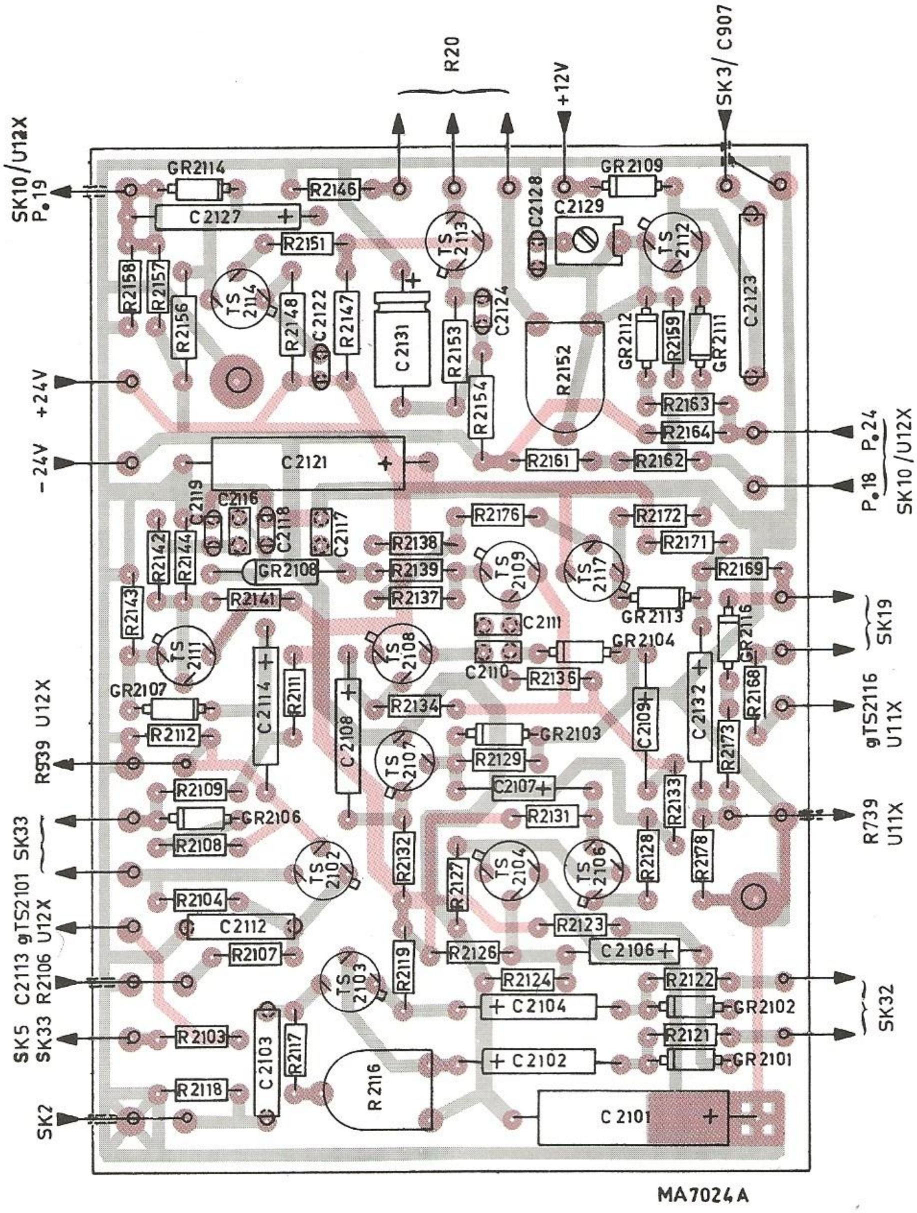
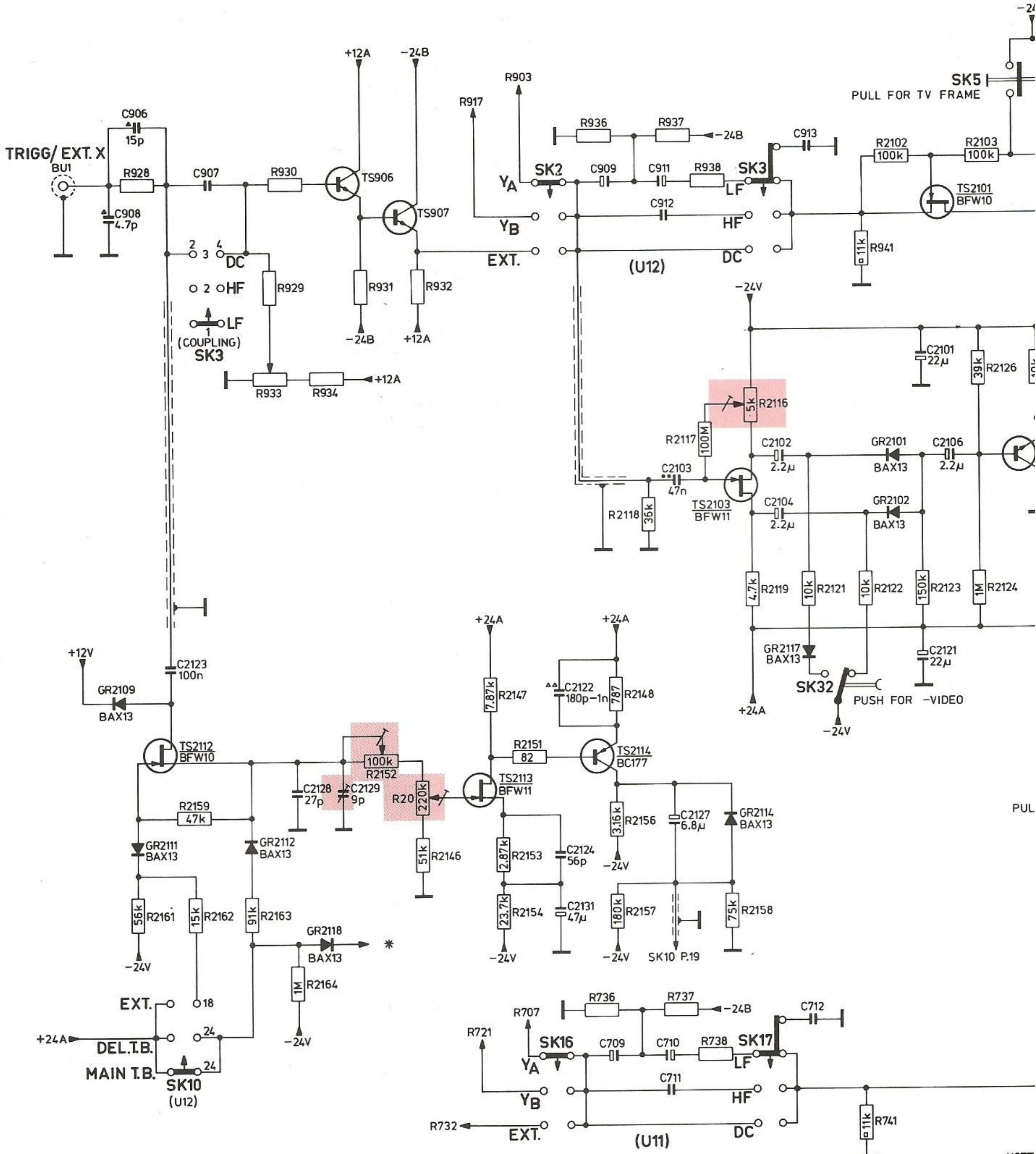


Fig. XIV-17a. Component location




✱ TO +24V SUPPLY POINT OF TRIGGER UNIT 25
(ORIGINAL +24V SUPPLY WIRE DISCONNECTED)

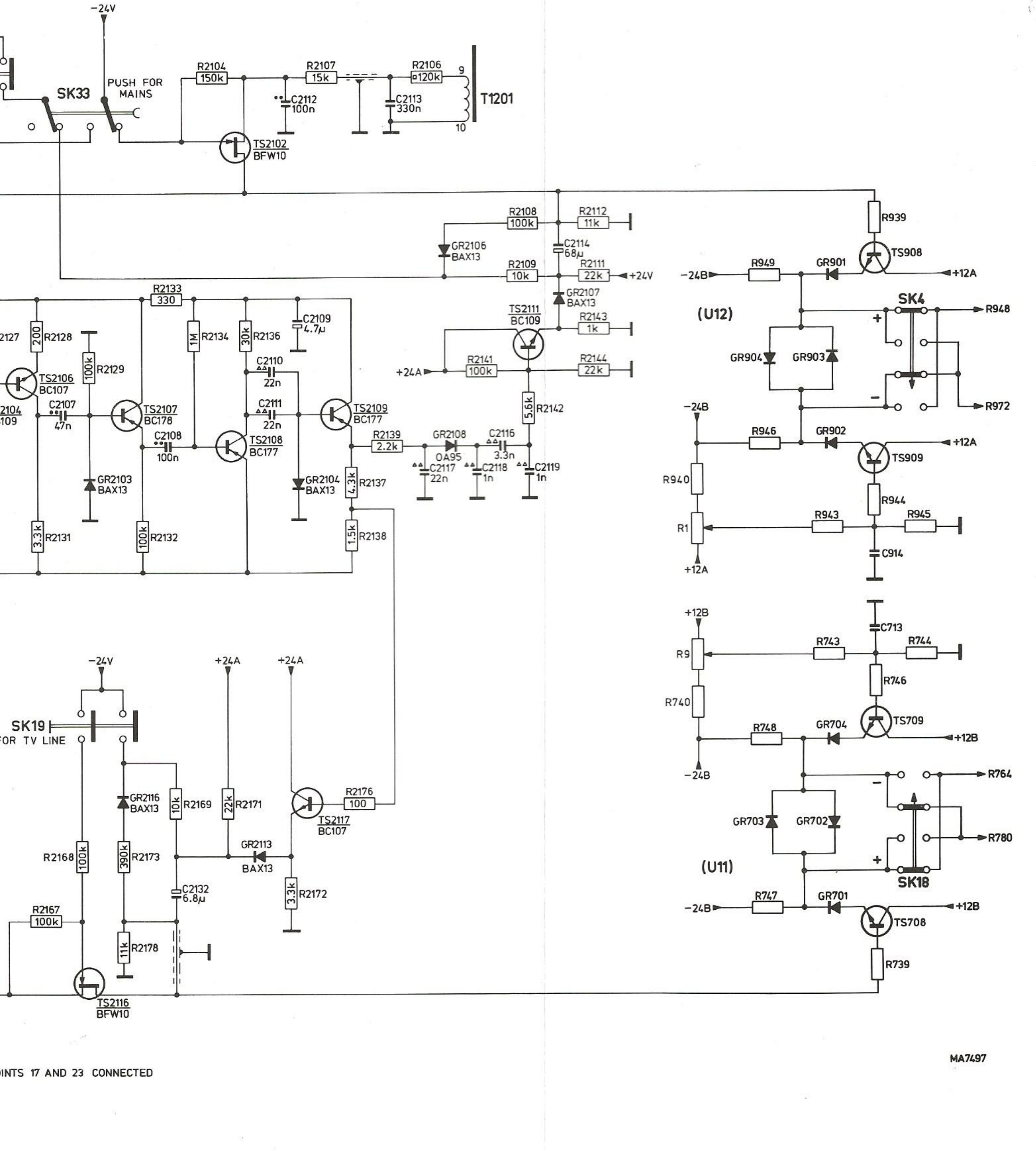



*Fig. XIV-17. Circuit diagram (with PM 3250 circuit modifications)*

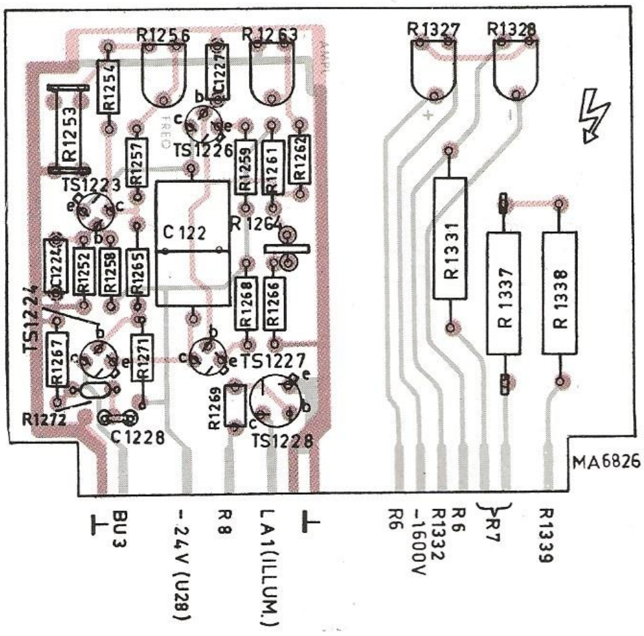



*Fig. XIV-18a. Components location*

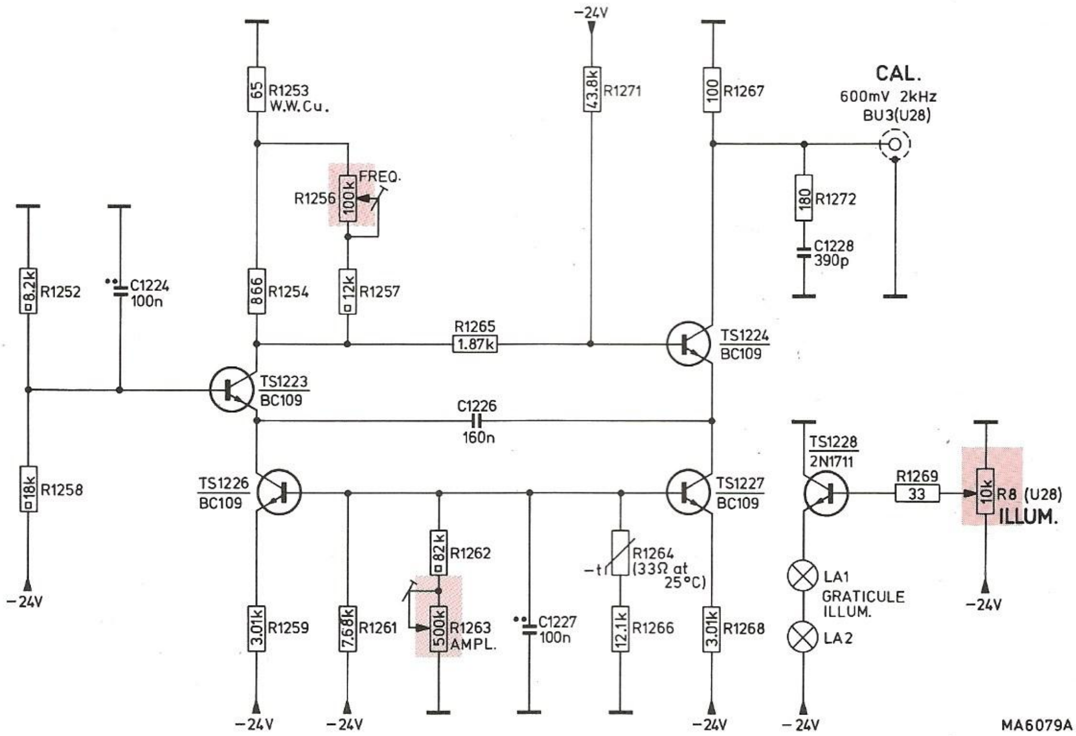
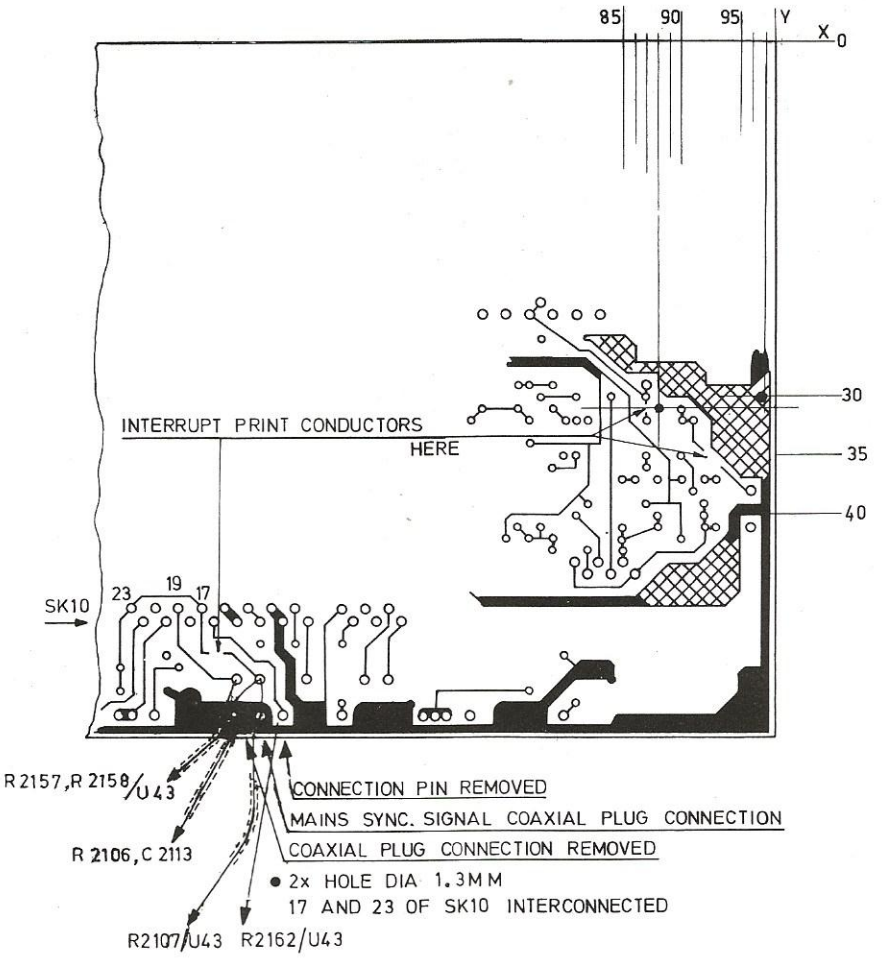
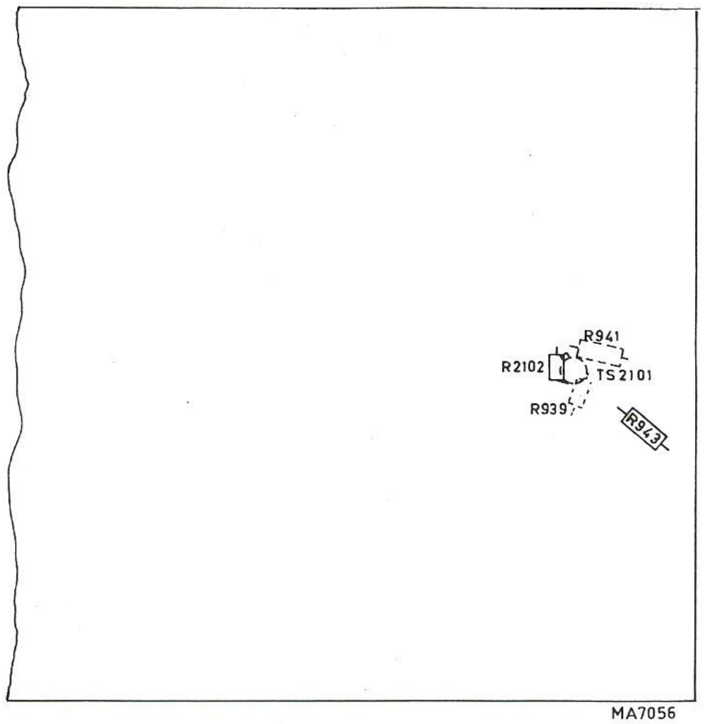



*Fig. XIV-18. Circuit diagram*

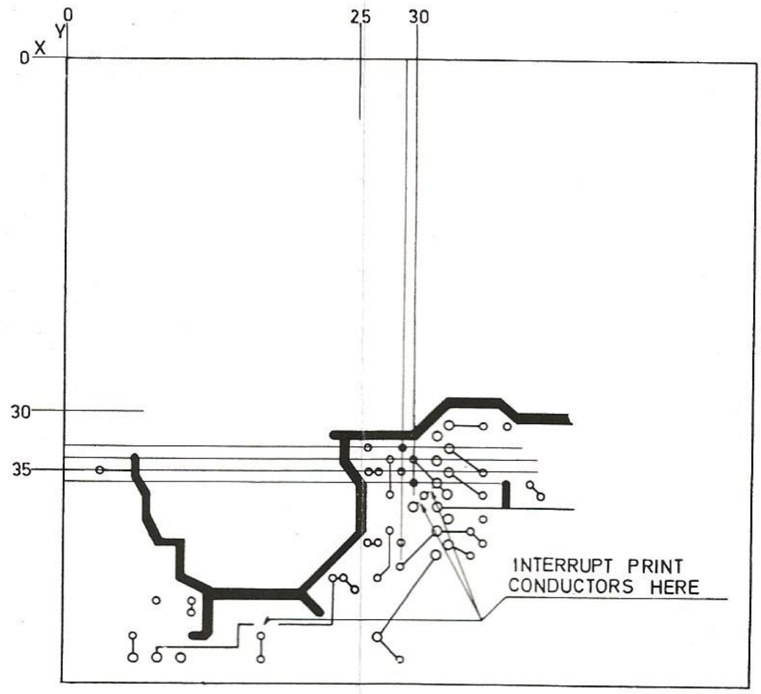


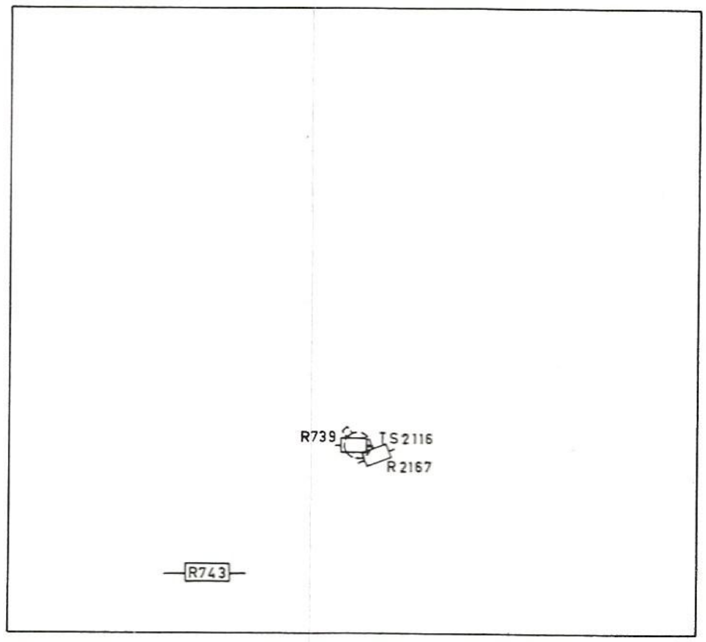

R 941 AND R939 DISPLACED (MOUNTED ON COMPONENTS-SIDE OF PRINT)
R943 AND R2102 MOUNTED
TS2101 MOUNTED ON COMPONENTS-SIDE OF PRINT

*Fig. XIV-19. Modification printed circuit board*

**MAIN TIME BASE UNIT 12, PM 3250X**
**(Rear side)**




• 2x HOLE DIA 1.3MM




MA7055

R739 DISPLACED
R743 AND R2167 MOUNTED
TS2116 MOUNTED ON COMPONENTS-SIDE OF PRINT

*Fig. XIV-20. Modification printed circuit board*

# QUALITY REPORTING

## CODING SYSTEM FOR FAILURE DESCRIPTION

The following information is meant for Philips service workshops only and serves as a guide for exact reporting of service repairs and maintenance routines on the workshop charts.
For full details reference is made to Information G1 (Introduction) and Information Cd 689 (Specific information for Test and Measuring Instruments).

### LOCATION

☐☐☐☐

Unit number
e.g. 000A or 0001 (for unit A or 1; not 00UA or 00U1)

or: Type number of an accessory (only if delivered with the equipment)
e.g. 9051 or 9532 (for PM 9051 or PM 9532)

or: Unknown/Not applicable
0000

### CATEGORY

☐

0 Unknown, not applicable (fault not present, intermittent or disappeared)
1 Software error
2 Readjustment
3 Electrical repair (wiring, solder joint, etc.)
4 Mechanical repair (polishing, filing, remachining, etc.)
5 Replacement
6 Cleaning and/or lubrication
7 Operator error
8 Missing items (on pre-sale test)
9 Environmental requirements are not met

### COMPONENT/SEQUENCE NUMBER

☐☐☐☐☐☐

Enter the identification as used in the circuit diagram, e.g.:

| | |
|---|---|
| GR1003 | Diode GR1003 |
| TS0023 | Transistor TS23 |
| IC0101 | Integrated circuit IC101 |
| RO.... | Resistor, potentiometer |
| CO.... | Capacitor, variable capacitor |
| BO.... | Tube, valve |
| LA.... | Lamp |
| VL... | Fuse |
| SK.... | Switch |
| BU.... | Connector, socket, terminal |
| TO.... | Transformer |
| LO.... | Coil |
| XO.... | Crystal |
| CB.... | Circuit block |
| RE.... | Relay |
| ME.... | Meter, indicator |
| BA.... | Battery |
| TR.... | Chopper |

Parts not identified in the circuit diagram:

| | |
|---|---|
| 990000 | Unknown/Not applicable |
| 990001 | Cabinet or rack (text plate, emblem, grip, rail, graticule, etc.) |
| 990002 | Knob (incl. dial knob, cap, etc.) |
| 990003 | Probe (only if attached to instrument) |
| 990004 | Leads and associated plugs |
| 990005 | Holder (valve, transistor, fuse, board, etc.) |
| 990006 | Complete unit (p.w. board, h.t. unit, etc.) |
| 990007 | Accessory (only those without type number) |
| 990008 | Documentation (manual, supplement, etc.) |
| 990009 | Foreign object |
| 990099 | Miscellaneous |

# Verkauf und Service über die ganze Welt

**Argentina**: Philips Argentina S.A., Cassila Correo 3479, Buenos Aires; tel. T.E. 70, 7741 al 7749

**Australia**: Philips Electrical Pty Ltd., Philips House, 69-79 Clarence Street, Box 2703 G.P.O., Sydney; tel. 2.0223

**België/Belgique**: M.B.L.E., Philips Bedrijfsapparatuur, 80 Rue des Deux Gares, Bruxelles; tel. 230000

**Bolivia**: Philips Sudamericana, Casilla 1609, La Paz; tel. 5270-5664

**Brasil**: S.A. Philips Do Brasil, Inbelsa Division; Avenida Paulista 2163; P.O. Box 8681, Sao Paulo S.P.; tel. 81-2161

**Burundi**: Philips S.A.R.L., Avenue de Grèce, B.P. 900, Bujumbura

**Canada**: Philips Electronic Industries Ltd., Electronic Equipment Division, Philips House, 116 Vanderhoof Avenue, Toronto 17 (Ontario); tel. 425-5161

**Chile**: Philips Chiléna S.A., Casilla 2687, Santiago de Chile; tel. 35081

**Colombia**: Industrias Philips de Colombia S.A., Calle 13 no. 51-03, Apartado Nacional 1505, Bogota; tel. 473640

**Costa Rica**: Philips de Costa Rica Ltd., Apartado Postal 4325, San José; tel. 210111

**Danmark**: Philips Elektronik Systemer A/S Afd. Industri & Forskning; Strandlodsvej 4 2300-København S; Tel (0127) AS 2222; telex 27045

**Deutschland** (Bundesrepublik): Philips Elektronik Industrie GmbH, Röntgenstrasse 22, Postfach 630111, 2 Hamburg 63; tel. 501031

**Ecuador**: Philips Ecuador S.A., Casilla 343, Quito; tel. 239080

**Eire**: Philips Electrical (Ireland) Ltd., Newstead, Clonskeagh, Dublin 14; tel. 976611

**El Salvador**: Philips de El Salvador, Apartado Postal 865, San Salvador; tel. 217441

**España**: Philips Ibérica S.A.E., Avenida de America, Apartado 2065, Madrid 17; tel 2462200

**Ethiopia**: Philips Ethiopia (Priv. Ltd. Co.), P.O.B. 2565; Cunningham Street, Addis Abeba; tel. 48300

**France**: Philips Industrie, Division de la S.A. Philips Industrielle et Commerciale 105, Rue de Paris, 93 002 Bobigny; tel. 84527-09

**Ghana**: Philips (Ghana) Ltd., P.O.B. M 14, Accra; tel. 66019

**Great Britain**: Pye Unicam Ltd., York Street, Cambridge; tel. (0223) 58866

**Guatemala**: Compañia Comercial Philips de Guatemala S.A., Apartado Postal 238, Guatemala City; tel. 64857

**Hellas**: Philips S.A. Hellénique, B.P. 153, Athens; tel. 230476

**Hong Kong**: Philips Hong Kong Ltd., P.O.B. 2108, St. George's Building, 21st floor, Hong Kong; tel. H-249246

**India**: Philips India Ltd., Shivsagar Estate, Block "A", Dr. Annie Besant Road, P.O.B. 6598, Worli, Bombay 18; tel. 370071

**Indonesia**: P. T. Philips Development Corporation, Djalan Proklamasi 33, P.O.B. 2287, Djakarta; tel. 51985-51986

**Iran**: Philips Iran Ltd., P.O.B. 1297, Teheran; tel. 48344-68344

**Island**: Heimilistaeki SF, Saetún 8, Reykjavik; tel. 24000

**Islas Canarias**: Philips Ibérica S.A.E., Triana 132, Las Palmas; Casilla 39-41, Santa Cruz de Tenerife

**Italia**: Philips S.p.A., Sezione PIT; Via Le Elvezia 2, 20052 Monza; tel. (039) 361-441; telex 35290

**Kenya**: Philips (Kenya) Ltd., P.O.B. 30554, Nairobi; tel. 29981

**Malaysia**: Electronic Supplies (Malaysia) Sdn Bhd. P.O. Box 332, Kuala Lumpur; tel. 564173

**Mexico**: Philips Comercial S.A. de C.V., Uruapan 7, Apdo 24-328, Mexico 7 D.F.; tel. 25-15-40

**Nederland**: Philips Nederland B.V., Boschdijk, Gebouw VB, Eindhoven; tel. 793333

**Ned. Antillen**: N.V. Philips Antillana, Postbus 523, Willemstad; tel. Curaçao 36222-35464

**New Zealand**: Philips Electronical Industries (N.Z.) Ltd., Professional and Industrial Division, 70-72 Kingsford Smith Street, P.O.B. 2097, Lyall Bay, Wellington; tel. 73-156

**Nigeria**: Philips (Nigeria) Ltd., Philips House, 6 Ijora Causeway, P.O.B. 1921, Lagos; tel. 45414/7

**Nippon**: Nihon Philips Corporation, P.O.B. 13, Trade Center, Tokyo 105; tel. (03) 435-5211

**Norge**: Norsk A.S. Philips, Postboks 5040, Oslo; tel. 463890

**Österreich**: Oesterreichische Philips Industrie GmbH, Abteilung Industrie Elektronik, Triesterstrasse 64, A-1101 Wien; tel. (0222) 645511/31

**Pakistan**: Philips Electrical Co. of Pakistan Ltd., El-Markaz, M.A. Jinnah Road, P.O.B. 7101, Karachi; tel. 70071

**Paraguay**: Philips del Paraguay S.A., Casilla de Correo 605, Asuncion; tel. 8045-5536-6666

**Perú**: Philips Peruana S.A., Apartado Postal 1841, Lima; tel. 326070

**Philippines**: Electronic Development & Application Center, 2246 Pasong Tamo Street, P.O.B. 911, Makati Commercial Center, Makati Rizal D-708; tel. 889453 to 889456

**Portugal**: Philips Portuguesa S.A.R.L., Rua Joaquim Antonio d'Aquiar 66, Lisboa; tel. 683121/9

**Republique du Zaire**: Philips du Zaire S.C.R.L., 137, Boulevard du 30 Juin, B.P. 1798, Kinshasa

**Rwanda**: Philips Rwanda S.A.R.L., B.P. 449, Kigali

**Schweiz-Suisse-Svizzera**: Philips A.G., Binzstrasse 38, Postfach 8027, Zürich; tel. 051-442211

**Singapore**: Electronic Supplies (Singapore) Private Ltd. P.O. Box 4029, Singapore 21

**South Africa**: South African Philips (Pty) Ltd., P.O.B. 7703, 2, Herb Street, New Doornfontein, Johannesburg; tel. 24-0531

**Suomi**: Oy Philips Ab, Postboks 10255, Helsinki 10; tel. 10915

**Sverige**: Svenska A.B. Philips, Fack, Lidingövägen 50, Stockholm 27; tel. 08/635000

**Taiwan**: Yung Kang Trading Co. Ltd., San Min Building, 1st Floor, 57-1 Chung Shan N Road, 2 Section, P.O.B. 1467, Taipei; tel. 577281

**Tanzania**: Philips (Tanzania) Ltd., p/a P.O.B. 30554, Nairobi, Kenya

**Thailand**: Philips Thailand Ltd., 283, Silom Road, Bangkok; tel. 36980, 36984-9

**Türkiye**: Türk Philips Ticaret A.S., Posta Kutusu 504, Istanbul; tel. 453250

**Uruguay**: Philips de Uruguay, Avda Uruguay 1287, Montevideo; tel. 956 41-2-3-4

**U.S.A.**: Test and Measuring Instruments Inc.; 224 Duffy Avenue, Hicksville, L.I., N.Y. 11802; tel. (516) 433-8800; telex no. 510-221-1839

**Venezuela**: C.A. Philips Venezolana, Apartado Postal 1167, Caracas; tel. 360511

**Zambia**: Philips Electrical Ltd., Professional Equipment Division, P.O.B. 553 Kitwe; tel. 2526/7/8; Lusaka P.O. Box 1878

730101

For countries not listed and for information on changes of address:
N.V. Philips
Test and Measuring Instruments Dept.
Eindhoven - Netherlands